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Effects of Prairie Fire On Archeological Artifacts

Editor's Note: How do the caretakers of a "mixed site" (i.e. cultural and natural resources) decide on management techniques that speak in a balanced way to the complex needs of such a site? The following article describes how the stewards of one such NPS area are addressing this delicate and demanding task.

By Robert W. Seabloom, Rodney D. Saylor,
and Stanley A. Ahler

The Knife River Indian Villages National Historic Site (KNRI) was established to preserve the historical and archeological resources associated with the Mandan/Hidatsa (Plains) Indians and early white exploration of the west. The park harbors evidence of several centuries of human activity. It is noted for its earthlodge village sites (Fig. 1) and evidence of early agricultural development on the northern great plains.

Lewis and Clark and other Euro-American explorers visited the location and recorded important observations on the life of the Plains Indians. Modern cultural resource studies have revealed a wealth of archeological artifacts and historical sites within the 520 ha area.

The park, a linear tract on both sides of the Knife River, is comprised of floodplain with a forest type known as "Missouri River bottomlands," dominated by green ash and boxelder. In addition, higher elevation terrace zones consist of native prairie sites and former cropland.

The park is charged with three major objectives:

(1) to recreate the 1804 historic scene depicting earthlodge villages,

(2) to protect park resources from human and natural impacts, and

(3) to maintain, where compatible, the natural habitat.

Currently, all fires are suppressed. However, historical evidence demonstrates that natural and artificial fires were regular events in the mixed grass prairie, perhaps occurring in 5 to 10-year frequencies. In recent years, fire suppression has resulted in a steady buildup of grassland and riparian fuel loads, colonization of disturbed soils by invading plant species, and natural vegetative growth.

This situation has increased the chances of an uncontrolled wildfire which potentially could endanger the park's cultural resources as well as surrounding private property. However, it was not considered possible to design and implement a fire management plan to achieve the desired ecological benefits without first determining the impacts of grassland fire on significant cultural resources. Although over 20 years of fire ecology research allows ecologists to predict impacts on biotic communities, the possible impacts of prescribed burning on archeological resources are not well known.

Prairie Fire Research

A team of ecologists and archeologists from the University of North Dakota conducted studies in 1988-89 to (1) determine potential impact of prescribed

burns at KNRI on its archeological resources, and (2) develop a recommended burning program for vegetation management at the park.

The impacts of prairie fires on 10 representative archeological materials were evaluated in 4 experimental plots established at the University of North Dakota's Oakville Prairie Natural History Area, a native mixed grass prairie near Grand Forks (Fig. 2). Two separate burns were accomplished in October and November, 1988, and the test artifact materials were collected and analyzed for a variety of changes - in color, weight, structure, and morphology.

The North Dakota Study is one of the first to indicate that certain kinds of artifacts will be altered by fire in grassland settings, necessitating careful site management.

The experiments indicated that fire-related impacts to buried artifacts are negligible, but effects on surface-exposed artifacts will be significant, depending on artifact type and size. Virtually all surface artifacts will be scorched and smoke blackened, and the duration of this effect is unknown. Organic items, such as bone and antler remains, will be substantially altered by blackening and charring. Wood materials will be charred or consumed. Shell will be fractured or disintegrated. Many chipped stone items (flaking debris and tools) will be spalled (splintered or chipped) and pitted/fractured. Pottery will not be damaged structurally, but surface color may be altered. Small lead and glass items will be partially or fully fused or melted (Fig. 3). The structure of larger stone items such as natural rock, flint cobbles, and larger stone artifacts generally is not affected, although localized spalling may rarely occur.

The North Dakota data are unique. The majority of earlier reports on the effects of fire on artifacts have dealt with forested habitats, generally in the American Southwest or California. Few controlled studies have been conducted. The North Dakota study is one of the first to indicate that certain kinds of artifacts will be altered by fire in grassland settings, necessitating careful site management.

Prairie fires probably have little, if any impact on ceramic materials or cobble-sized rocks, a conclusion of significance to archeological interpretation. For example, fire-cracked rock in a grassland setting prob-

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Figure 1. Aerial view of the Big Hidatsa earthlodge village. A light snow cover helps outline the earthlodge depressions and the modern road.

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Contributors, Please Note!

Park Science has deadlines: Nov. 15 for Winter issue; Feb. 15 for Spring issue; May 15 for Summer issue; Aug. 15 for Fall issue. Copy that comes to the Editor after these dates usually cannot be used until the following issue.

Park Science also has only 24 pages per issue, thus adding "space" to "time" as an editorial constraint. Your Editor suffers over these limitations as much as you do. Alas, neither tears nor ulcers can change them.

Editorial

As an editor, looking back from the 10th anniversary of the publication, I felt an urge to take some notice of **Park Science's** first decade. The editorial page seemed the most likely place to do so, and with that in mind I browsed through old issues, hoping to find some former words of my own that simply cried out for ceremonial recognition. I didn't.

What I *did* find, however, was a couple of inclusions in the Spring 1983 issue, the re-printing of which is more than a mere salute to the past. One is the editorial by Peggy Herring on WHY scientists should write well, and the other, associated piece, is the article by Jim Wood on HOW to write scientific material for general public consumption. To print them again is a service to both the writers and the readers of **Park Science**.

So here are the words of Peggy Herring, who was a student of mine in a Natural Resource Communications class at Oregon State University, and who has since become an immensely successful science writer, with her own clientele and production capabilities and a wide sphere of influence as a result of having practiced what she preached.

The succinct advice of Jim Wood appears on page 13.

By Peggy Herring

I am a biologist and I want to learn to write.

I believe that the privilege of doing research carries with it a responsibility for interpreting technical ideas for the interested public who may be footing the bill.

Scientific research too often is a facts-and-figures account of research and management. This is useful for people who already are specialists in the field, but it does not inspire those who have no confidence in themselves to understand scientific concepts. Scientific policy affects all citizens, and we should have access to these ideas. We need this information to help us make decisions and understand their consequences.

Topics of science can be presented clearly and simply without losing their accuracy. Precision is relative to the needs of the audience. With modified precision (NOT compromised accuracy) the most obscure technical idea can become readable, understandable, to a non-scientific audience.

Also, there is an added value in viewing research in less detail. Focus is broadened so that trends in thought and relationships to other work become clearer.

I have one more personal reason to want to learn to write well. The commitment to interpret a certain topic of science is a demanding and effective way of learning about the subject. To collect the small puzzle pieces of research and organize ideas into a larger design is to experience the joy of discovery. This organizational process would be the same if the product were to be a written article, a videotape, or an illustrated display. I am sometimes more fluent in drawing a picture than I am in composing the thousand words it represents. But to write clearly is to think clearly, and so interpretation becomes discovery.

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Effects of Prairie Fire On Archeological Artifacts

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ably can be interpreted as a product of cultural rather than natural processes.

In addition, while surface deposits of bone and chipped stone can be expected to undergo significant alteration, the degree of alteration in these items is apparently less severe than can be caused by fire-related cultural processes, such as material from an open fire hearth.

These data will help the archeologist interpret the significance of several classes of archeological materials.

Site Management

The KNRI study indicated a potential conflict between the objectives of vegetation management to recreate the original native prairie setting, and protection of surface archeological resources. However, prior surveys demonstrated that artifacts are not randomly distributed on the park, but are concentrated in their highest densities at three major historic period village sites. Consequently, a management plan was developed that provided for differing levels and timing of fire treatment, based on surface artifact density.

The phased burning program that was recommended recognizes several categories of artifact densities and relative importance or sensitivity to burning.

The phased burning program that was recommended recognizes several categories of artifact densities and relative importance or sensitivity to burning.

Specific recommendations were that:

- (1) Major KNRI village sites not be burned until a



Figure 2. Test burn conducted at the University of North Dakota's Oakville Prairie.

thorough and professional collection of surface-visible artifacts is completed and preserved for future analysis;

- (2) Archeological sites at KNRI with moderate artifact densities be surveyed to determine whether surface collection is warranted to mitigate fire damage; and

- (3) Burning and other vegetation management programs may begin as soon as feasible on areas and portions of the park that have low artifact densities, archeological sites ineligible for the National Register of Historic Places, or sites not susceptible to fire damage.

In addition to prescribed burns, gradual logging, mowing, site-specific chemical treatment, and even

The KNRI study indicated a potential conflict between the objectives of vegetation management to recreate the original native prairie setting and protection of surface archeological resources.

grazing may be used to manipulate vegetation in several problem areas at KNRI that cannot easily be burned.

However, some management practices may be difficult to implement on such a small area without creating additional disturbance to natural vegetation (e.g. fence construction, trampling by bison and horses). Consequently the prudent development of a prescribed grassland burning program still remains the most feasible tool to attain the management goals of the park.

Seabloom is a professor of biology at the University of North Dakota; Saylor is director of the Institute of Ecological Studies at U/ND; Ahler is associate professor of anthropology at U/ND.

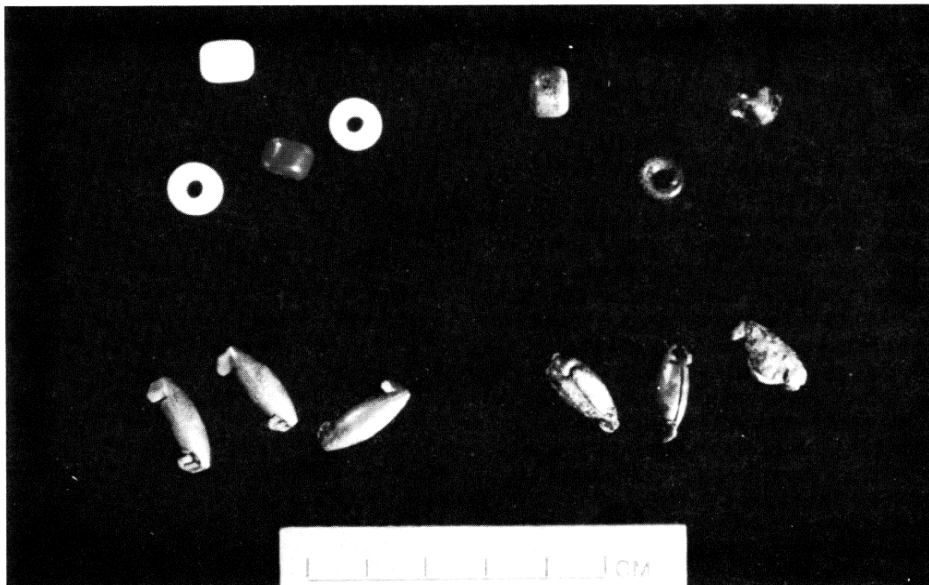


Figure 3. Effects of prairie fire on test artifacts: Unburned glass beads and lead sinkers on left, fire damaged samples are shown on the right.

2 LATE CALENDAR ITEMS

Feb. 22-23, Designing, Maintaining and Restoring the Native Landscape III, at Portland Community College, Rock Creek Campus, Portland, OR. Contact: Mark Wilson, (503) 222-0134.

July 21-25, Quadrennial Meetings of the International Association for Landscape Ecology (IALE), at Carleton College, Ottawa, Ontario, Canada. First time ever held in North America. Call for papers from Dr. Grey Merriam, (613) 788-3859.

Sociological Contributions to Everglades Backcountry Use Management Plan

By William P. Stewart, Ray W. Snow, and Mark I. Ivy

Of the 1.4 million acres comprising Everglades NP, all but approximately 20,000 acres can be considered backcountry, much of it relatively inaccessible because of dense Mangrove thickets, pinnacle rock and extensive mud flats. Most of the use is seasonal, occurring in the drier winter months when insect pests, heat, and humidity are less intense.

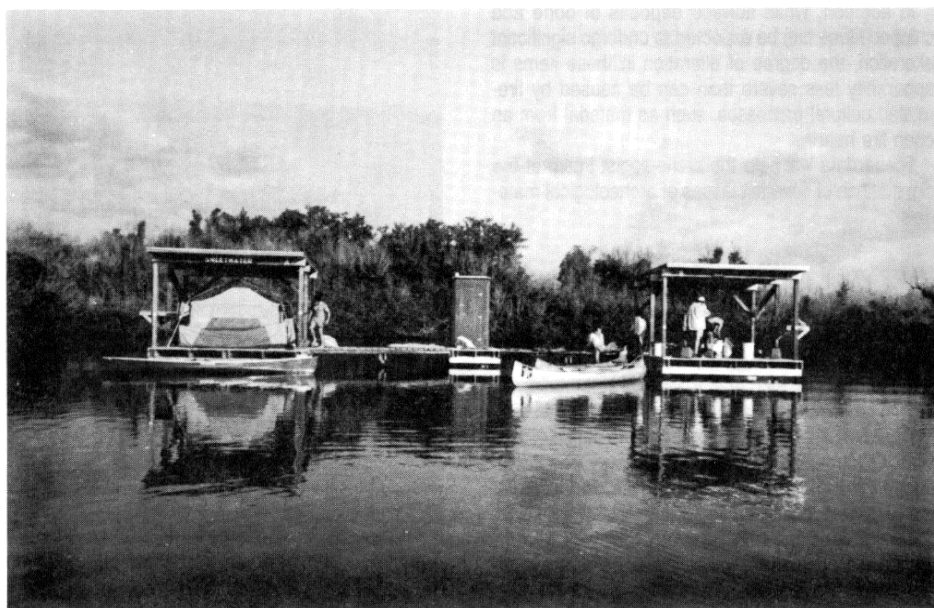
Prior to the 1960s, recreational use of Everglades consisted largely of day-use boating and fishing. Opportunities for overnight camping in the backcountry were limited due to extreme scarcity of high, dry ground. The increased demands for overnight camping during the 1960s led managers to construct "chickees" (i.e., covered wooden decks approximately five meters square, raised above the water on pilings) which has its origins with the Miccosukee Indians. Chickees allowed flexibility in establishing additional sites while minimizing impacts to natural resources. Continued increases in backcountry use during the 1970s led to the initiation of a voluntary overnight permit system in 1977, which was made mandatory in 1983. The purpose of the permit system was to establish campsite capacities, provide data to determine use levels, extend contact between the NPS backcountry staff and visitors, and to aid in search and rescue operations within the park. A backcountry function in Resource Management was established in 1978 and a Backcountry Management Plan adopted in 1981. Backcountry use continued to increase throughout the 1980s, giving rise to concern about the effectiveness of policies and regulations stemming from the 1981 plan.

The primary goal of backcountry use management is to provide park visitors access to a variety of primitive recreational opportunities without incurring unacceptable change to the resource or disturbance to the experiences of others. If we were to revise adequately the 1981 plan, it was clear that we needed sociological information regarding the user experience.

The Backcountry User Study

To provide this sociological information, a study of wintertime backcountry users at Everglades NP was begun in 1988 and recently was completed. This study was formulated as a cooperative agreement between the NPS and Texas A&M University. After several telephone consultations and an onsite orientation meeting with researchers from both Texas A&M and the CPSU at Virginia Polytechnic Institute, the following study objectives were developed: (1) to identify the overnight and day users of the park's backcountry; (2) to determine the motivations, expectations and preferences for overnight and day users; (3) to measure overnight and day users' levels of satisfaction with their Everglades experience; (4) to evaluate overnight users' reaction to the present permit issuance and itinerary system; (5) to develop a sociological monitoring system that could be used by the park staff; (6) to provide the initial database to be used in backcountry travel simulation models; (7) to suggest management actions that best meet social needs.

Full cooperation between NPS and Texas A&M was essential. Development of the research proposal was a negotiated effort involving staff people from several ranks at Everglades and Texas A&M researchers. This research involved sending a map of the Everglades



Current-day "chickees" of Everglades National Park have their origins with the Miccosukee Indians. Photo by Garrett Moynihan.

backcountry to each of the sampled users, requesting the respondent to trace the route of their trip. The Everglades' staff, along with the graphics specialists from the NPS Harpers Ferry Center, developed an 11 x 17-inch map insert for the questionnaires. Part of the sampling procedures required a Graduate Research Assistant from Texas A&M to conduct face-to-face interviews with daytime users of the backcountry. During the three months of the study, the Everglades' staff provided park housing and office space for the student, and access to computer equipment, secretarial and mail assistance, along with facilitating lines of communication between the student and park employees.

A first draft of the technical report was submitted to Everglades NP in October 1989. During December 1989, the investigators from Texas A&M, along with Jeff Marion (Unit Leader and Research Biologist, CPSU at VPI), met at Everglades to discuss the study, the final report, and policy recommendations emerging from the study.

Backcountry User Study Synopsis

Since overnight and day users are found in most areas of the park's backcountry, information was needed from both of these user types. As a result, two concurrent surveys were administered during January, February and March of 1989. The results were based upon 482 day users (representing an 83% response rate) and 380 overnight users (representing an 81% response rate) who were randomly sampled and mailed-back completed questionnaires. The findings indicated that the characteristics of Everglades backcountry users represent a diverse array of previous backcountry experience, motivations, preferences, behavioral patterns and socio-demographic attributes. The majority of backcountry visitors surveyed achieved high levels of satisfaction with most aspects of their experience.

Of the respondents to the day user survey, 84 percent of the motorboaters and 46 percent of the canoe-

ists came from Florida. Of the respondents to the overnight user survey, 89 percent of the motorboaters and 36 percent of the canoeists reported Florida as their state of residence. *These data indicated that the Everglades backcountry is a popular resource for Florida motorboaters and a nationally recognized resource for canoeists.*

By a wide margin and across both samples, viewing wildlife surpassed all other reasons as the most popular motivation for visiting Everglades backcountry. Compared to canoeists, motorboaters were more likely to emphasize releasing tensions and fishing as motivations for visiting the backcountry. Compared to motorboaters, canoeists were more likely to emphasize solitude and physical exercise as motivations.

The issue of crowding is typically a concern for backcountry recreation managers. Respondents were asked to report their satisfaction level with the number of other people encountered during the daytime; 12 percent reported dissatisfaction. However, when asked to report on their satisfaction with the number of motorboats encountered, 46 percent of canoeists compared to 11 percent of motorboaters, expressed dissatisfaction. When asked to report on their satisfaction with the number of canoes encountered, 4 percent of canoeists, compared to 11 percent of the motorboaters, expressed dissatisfaction. Also when asked to report on the degree of crowding during the daytime, 63 percent of canoeists, compared to 39 percent of motorboaters, expressed some feeling of crowding. These data suggest that if one were to be concerned with potential crowding problems in the backcountry at Everglades NP, reducing the number of encounters would be less relevant than reducing the likelihood of encounters between different types of groups.

The compliance rate to the permit itinerary system for overnight use was estimated, in part, based upon the respondents' traced route of their trip on a map enclosed with the questionnaire. Seventy-one percent

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Parks, Pollution, and People: An International Conference on Management Of Protected Areas Under Atmospheric Emission Impact

By John D. Peine

The objective of the conference held June 3-9, 1990, at Krkonose (Giant Mountains) NP, Czechoslovakia, was to explore the impacts of air pollution on national parks and other protected areas, with special attention to the biological diversity of forest ecosystems, in order to prescribe practical measures to be implemented immediately, before the sources of pollution can be reduced or eliminated.

International review papers were presented, dealing with topics such as an overview of air polluted environments in central and eastern Europe, review of critical loads and levels of air pollutants, natural heritage sites and climate change, forest dieback and atmospheric pollution in Europe, impacts on aquatic systems, on soils, and on recreation and tourism. Concurrent sessions dealt with air pollution related problems in specific national parks and like reserves in Norway, Nova Scotia, Canada, Czechoslovakia, Poland, what was then East and West Germany, and the United Kingdom.

The intended output of the conference was to establish practical guidelines for management of protected areas subject to emission impacts. These yet-to-be-published guidelines will be based on papers and case studies prepared in advance for discussion, with the provision of approval by the conference. Problems and some solutions were examined during a field day excursion into the Krkonose NP.

My role was to provide a case study of a national park in the U.S. with related biogeographic characteristics to that of eastern Europe as a point of comparison of how a park-level air quality management program has been conducted in the U.S. The intent was to look, in broadest terms, at the management program, ranging from emission control standards to monitoring, research of environmental effects, education, and mitigation activities. I altered my prepared presentation, which followed a field day, in order to draw more direct comparisons between Great Smoky Mountains NP and Giant Mountains NP.

As in the Smokies, the forests in Giant Mountain park are difficult to assess in terms of the adverse impact from air pollution because of the exacerbating influence of a high tree mortality from insect infestation. At Giant Mountains there has been a major bark beetle infestation of Norway spruce trees. Air pollution effects are further complicated by the fact that the vast majority of the park's forests are a monoculture of Norway spruce that were planted 50 to 80 years ago almost universally over the landscape, establishing the potential for stress associated with marginal nutrient and climatic conditions and a high degree of vulnerability to insect pests and pathogens. Although the pollutant loading is significant in the park, no papers were presented that conclusively demonstrated a direct cause/effect relationship between air pollution and vulnerability to mortality related to insect infestation.

tion, which is the working hypothesis concerning the forest decline in the park.

Dead and dying trees currently are being removed via a clearcut logging operation with poor success rate of tree regeneration following these operations. A spirited and emotional debate occurred during the field trip between the newly elected park superintendent and the forester in charge of logging operations in the park. It was a clear demonstration of the emerging philosophy to manage parks based on ecological principles as opposed to the entrenched policy associated with land management practice to remove diseased trees. The ecologists had grave doubts as to the wisdom of massive landscape disturbance associated with the logging operations.

The very fact that the debate was going on openly, in front of conference attendees, was an extraordinary event, considering that the previous park superintendent had only recently been released from prison, where he had been sentenced to 8 years for criticizing government plans to build yet another ski resort in the park.

The challenges facing the management team at Giant Mountain NP are formidable in the light of the magnitude of air pollution loading and the desperate need to restore natural forest ecosystems in a polluted environment of depleted soil nutrients.

I view the conference as an extremely important and personal learning experience – observing the struggles these enlightened leaders in eastern Europe are facing. We in the U.S. NPS should open communication with these people, who are at the forefront in trying to maintain and restore ecosystems in national parks. The difficult lessons they are learning will be applicable in the U.S. National Park System in the future. There is much to learn from our European colleagues about our own future.

Peine is Science Administrator at the Uplands Field Research Laboratory, Great Smoky Mountains NP.

Everglades Backcountry (Continued from page 4)

of backcountry trips were in compliance with their permit itinerary. Thus, in terms of permit itinerary information being valid indicators of site-specific use information, it should be recognized that there were substantial discrepancies between recorded and actual use of the backcountry campsites.

The effect of *noncompliance* is an important consideration at Everglades, since designated campsites are relatively small. When overnight users were asked if they were bothered by campers who were not complying with the itinerary system, 10 percent responded that they were bothered. Another item was directed at respondents who had reported sharing their site with non-complying campers; the results indicated that campers who deviated from the itinerary of their permit can have a positive (3%), negative (11%), or neutral (9%) effect on other campers (percentages based upon the complete sample of overnight users). Thus, in terms of the sociological impact of permit non-compliance, the proportion of overnight visitors who were negatively affected by noncomplying campers was about one-third the proportion of noncomplying campers.

Use of campsites by day visitors also was a concern and could be related to the amount and quality of impacts. Of the respondents who were day users, 27 percent reported that they stopped at a backcountry campsite area and of those that stopped, 43 percent

reported that at least one person in their party used the restroom facility on the site.

Backcountry User Study Conclusion

The recommendations from this study were based upon the results of the study, the effectiveness of policies at analogue park areas, the collective professional judgments (as reported in literature) of scholars and land managers associated with outdoor recreation, and the authors' past experiences and opinions. The suggested order of importance of the recommendations was: (1) enhance and expand the diversity of recreational experiences afforded by the park's backcountry; (2) expand the number of designated sites within close proximity to trailheads; (3) maintain the current fixed itinerary system; (4) maintain and improve backcountry trip planning facilities; (5) adopt an advance reservation system for allocation of a portion of user nights; (6) modify the pumping schedule for sanitary facilities at heavily-used backcountry sites.

Stewart is Assistant Professor in Texas A&M's Department of Recreation, Park and Tourism Sciences, College Station, TX 77843-2261; Snow is Natural Resource Management Specialist at Everglades NP; Ivy recently completed a Masters degree at Texas A&M. For a copy of the technical report write the first author.

In the Next Issue

"Reclamation of Abandoned Mines at New River NR, Gouley River NRA and Bluestone NSR" by Carol A. Pollio; Sea-Kayakers at Apostle Islands National Lakeshore: Summary of a 1989 Exploratory Study," by Carolyn C. Phelps and David W. Lime; "Chiricahua Mts. Annotated Bird Checklist" by Kathy L. Hiett, R. Roy Johnson and Michael R. Kunzmann; "Using GIS for Assessment and Forecast of Impacts From Dredging and Oil Transport on NPS Barrier Islands," by Samuel Patterson and Richard Dawson; "Effects of Stocked Fish on Naturally Baren Mountain Lake Communities," by William Liss and Gary Larson; and "New Perspectives in Science," an essay by William E. Brown.

Red Wolves Thrive at Gulf Islands

By Ted Simons, John Weller,
Robert Esher and Dwight Bradshaw

The red wolf (*Canis rufus*) is the native wolf of the Southeast (Nowak 1979). Originally, it inhabited forests and swamps from central Texas to the Atlantic and from the Gulf Coast to the Ohio Valley and Pennsylvania. Unlike larger grey wolves (*Canis lupus*) which form packs of eight or more individuals, red wolves live in small family groups.

The red wolf is an opportunistic predator that preys primarily on small mammals. Studies in east Texas and Louisiana indicated the wolves feed almost exclusively on rabbits (*Sylvilagus aquaticus* and *S. floridanus*), nutria (*Myocastor coypus*) and cotton rats (*Sigmodon hispidus*) (Shaw 1975; Carley 1975).

The red wolf was extirpated from most of its range by the 1930s, although it survived in isolated pockets in the lower Mississippi Valley until much later (Wolfe 1972; Paradiso and Nowak 1972). The last wild wolves inhabited coastal prairies and salt marshes in east Texas and Louisiana. All the red wolves alive today are descendants of 15 individuals trapped in east Texas in the late 70s to form the nucleus of a captive breeding program (Parker et al. 1989).

Extinct in the world for almost 15 years, red wolves were returned to a portion of their former habitat in 1987, when eight wolves were released at Alligator River National Wildlife Refuge – the first step in an ambitious restoration program directed by the USFWS. By that time all the remaining wolves were second or third generation captive reared animals. Clearly the transition to independence in the wild would be difficult.

In 1988, the red wolf recovery team approached the NPS about using Horn Island, a 1300 ha wilderness area within Gulf Islands National Seashore, as a site to propagate wild red wolves (Parker 1987, 1988). Objectives of the proposed 5-year project would be to release a pair of wolves on the island, study their biology and their effects on the ecosystem, and use any wild offspring produced in restoration projects at Alligator River or other mainland sites. The hope was that wild reared wolves would have a higher survival rate than animals born and raised in captivity.

A recently completed 3-year baseline study on the island's small mammal populations (Esher et al. 1988) had raised concerns about the effects on island vegetation of introduced rabbits and nutria, and this fact, together with the hope of contributing to the recovery of the wolves, caused Supt. Jerry Eubanks to approve the wolf recovery project in the fall of 1988.

Two adult red wolves were flown to Mississippi from Alligator River NWR, NC, on Jan. 10, 1989. The male had been raised at Audubon Zoo in New Orleans, the female at the captive breeding program run by the Point Defiance Zoo in Tacoma, Wash. When they were brought to Horn Island, the male was five years old, the female, six. They were released into a 15 x 15 holding pen on Horn Island and fed fresh meat (deer, beaver, nutria, and rabbits) daily.

They quickly acclimated to their new surroundings and, while still in the pen, the female became pregnant and gave birth to seven healthy pups (4 males and 3 females) on May 6. On July 12, the pups were transported to Ocean Springs, where transmitters were surgically implanted. Their weights ranged from 4.4 to 4.8 kg. On July 28, the wolves were captured, given their final worming and vaccinations, and weighed. The female weighed 25 kg, the male 33.7 kg, and the pups

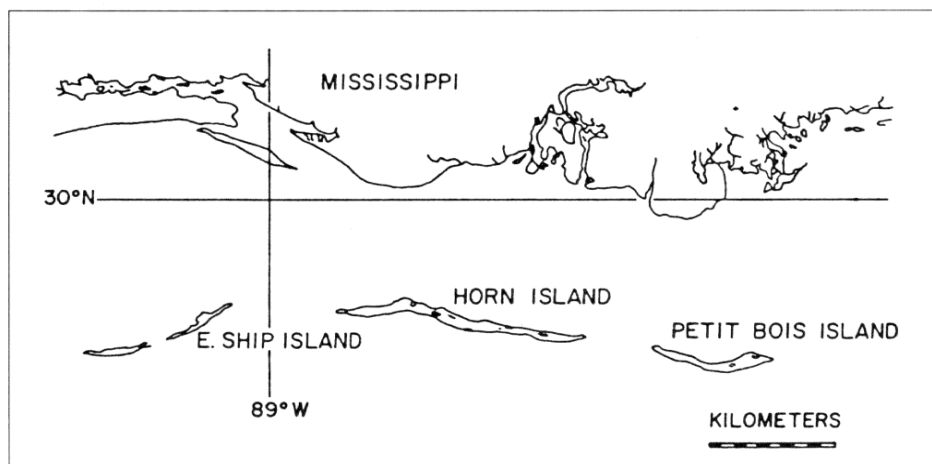


Figure 1. Horn Island is a 1300 ha wilderness area located 10 km off the Mississippi coast.

averaged 6.3 kg (5.7-6.5 kg). All nine were released into the wild on July 31, 1989.

An on-going research project has provided information on the biology of the wolves and their effect on the island ecosystem over the past year.

Radio telemetry studies of the wolves' movements revealed that within a month of their release the adult wolves were hunting successfully and regularly traversing the entire 22 km length of the island. By the time the pups were five months old they were accompanying the adults on extended nightly hunting trips.

Monitoring of the small mammal populations has continued on a bi-annual basis, using a combination of live trapping grids, baited tracking stations, and unbaited cross-island tracking transects. These studies have documented changes in populations of several species. Wolves are excluding rabbits, nutria, and raccoons from open habitats. Nutria, which once foraged extensively on sea oats in the primary dunes, now are restricted to marsh habitats and their numbers probably have been reduced as well. Raccoons now are found almost exclusively in forested habitats and their numbers also may have been reduced. Rabbit

numbers appear stable, although wolf predation apparently is causing a shift in the population age structure toward younger animals.

We hope to monitor the secondary effects of these changes (e.g. the response of the vegetation to reduced grazing by nutria and rabbits or the response of sea turtle, alligator, and osprey populations to reduced predation by raccoons) in the years ahead. Food habits studies indicate that the wolves are feeding primarily on rabbits (70% of diet), raccoons (15%), and nutria (10%). The remainder of their diet includes vegetation, insects, fish, crustaceans, and birds.

The original plan for the Horn Island Project called for maintaining a single pair of adult wolves on the island and removing any pups produced each winter for eventual release at Alligator River or mainland sites. That plan was modified last winter due to the large number of pups produced and the death of the adult female.

The adult male and two male pups were trapped in January 1990 and sent to Alligator River. The remaining five pups were left on the island where they have thrived over the past nine months. These five wolves, now full grown, were to be trapped in November 1990, and one female selected to remain on the island. She will be paired with a new adult male this winter in the hope that they will produce another litter of pups next spring.

One female will be sent to Great Smoky Mountains NP as part of a new project set to begin there in January 1991. Plans are underway to release red wolves into the Cades Cove area of the park as part of a research project to assess the suitability of the park as a restoration site. The remaining female and two male wolves from Horn Island will be sent to Alligator River for eventual release on the refuge there. It is hoped that the skills and wild instincts developed by these animals on Horn Island will improve their chances of survival at mainland sites.

Horn Island, Miss., appears to be an excellent place to rear and study red wolves. The wolves removed from the island in January were in superb condition and the transition from captivity to the wild in these animals appears complete. In spite of the fact that there are 20-30,000 visitors to Horn Island each year, no encounters or sightings of red wolves have been reported.



Figure 2. Resources Management Specialist Gary Hopkins assists Biological Technician Robin Tillman in vaccinating a 10-week-old red wolf pup.

Concluded on page 7

RABBIT AGE STRUCTURE BEFORE AND AFTER WOLF RELEASE

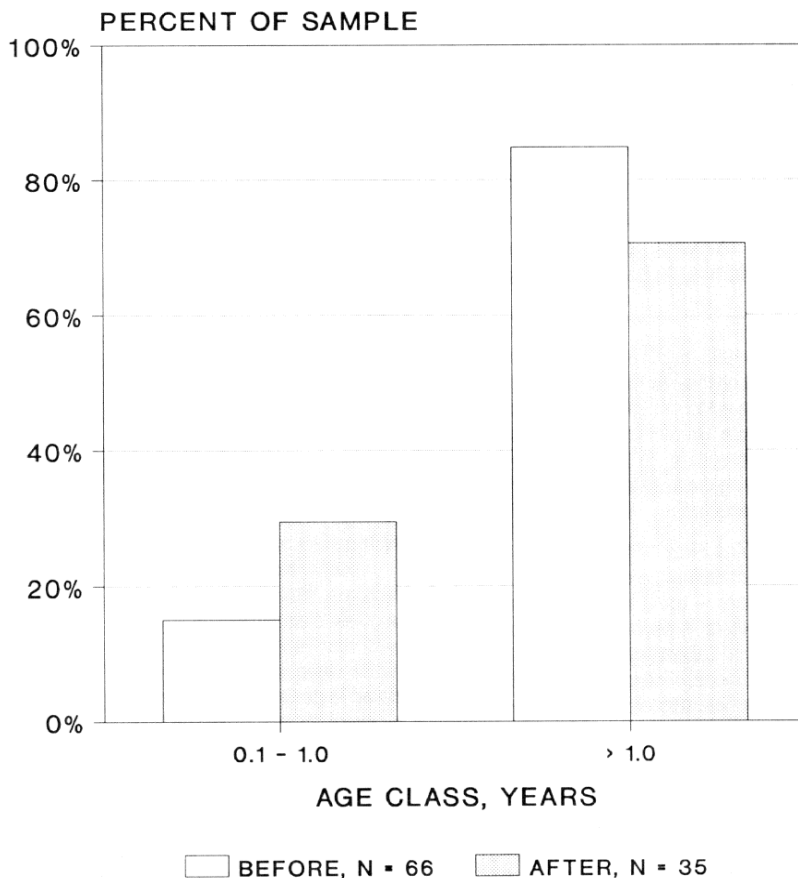


Figure 3. Comparison of age of cottontail rabbits on Horn Island before and after red wolf release.

Red Wolf Diet Horn Island

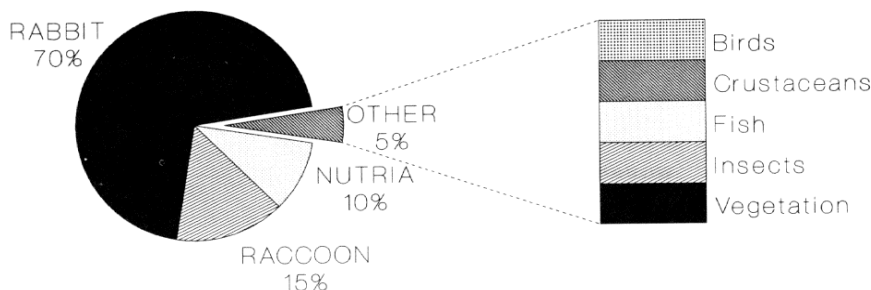


Figure 4. Composition of red wolf diet August 1989 - August 1990, n = 91.

Research on the prey populations is providing new insights into the role of predators in ecosystems and the effects of exotic herbivores on barrier islands. We believe that, as more data become available from this and other projects, biologists will be able to make better decisions on the management of this and other large carnivores.

Simons is a research biologist and Weller a biological technician at Gulf Islands National Seashore; Esher and Bradshaw are research biologists with Mississippi State University.

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New Plant Discovered in Guadalupe NP

Discovery of a new species, *Viola guadalupensis*, in Guadalupe Mountains NP, was announced at a press conference held the first morning (November 12) of the George Wright Society conference in El Paso, TX. Brent Wauer, a park ranger at Guadalupe Mountains, stumbled upon a small population (about 35) of these yellow violets growing on a limestone cliff in a remote canyon while he was exploring on his day off.

This was March 22, 1987. After an exhaustive study and chromosome check, Dr. Michael Powell, a botanist at Sul Ross State University in Alpine, TX, concluded more than 3 years later that this was indeed a new *Viola*. Only two other violet species, both blue-flowered, are known from the park. Wauer speculates that *V. guadalupensis* might be a relict species from wetter times in the past 8-10,000 years.

At the press conference, Regional Director John Cook unveiled a painting of *Viola guadalupensis* by Santa Fe artist Steven Boone. A color poster of this painting is available from the Carlsbad Caverns-Guadalupe Mountains Association at Carlsbad. Cook commended on the value of national parks for sheltering diversity of plant and animal life, including rare forms such as this new violet. He said it would be an immediate candidate for endangered species status.

(picture in next issue)

Ungulate Populations Models and Carrying Capacity

Predicting Effects of Fires, New Winter Range, and Proposed Wolf Reintroduction

By Francis Singer

A workshop to reconsider the subject of elk and bison carrying capacities in Yellowstone NP and to predict the effects of the dramatic events of 1988-90 was held in the park April 5-7, 1990. The "dramatic events" included the burning of 30 to 50 percent of the park's ungulate winter ranges during the large fires of 1988. The fires and drought of 1988, followed by a severe winter, precipitated a large migration of elk and bison from the park, large harvests of both elk and bison in Montana, and large winterkills. Approximately 24 to 26 percent of the northern elk herd winterkilled and 14 to 16 percent of the elk herd was harvested.

Public concern over the extent of the winterkill prompted a large fund raising effort by the Rocky Mountain Elk Foundation. In cooperation with the USFS and the NPS, 7,100 acres of private lands on historic winter ranges were purchased (Fig. 1) with a combination of private and federal appropriated funds. In 1987, the Northern Rocky Mountain Wolf Recovery Plan proposed restoring wolves to Yellowstone and adjacent public lands. The USFWS and NPS were directed by Congress to determine how wolves would affect their prey in the park and big game hunting in areas around the park (Wolves for Yellowstone? 1990).

The Concept of Ungulate Carrying Capacity in Yellowstone

During the droughts of the 1930s, Yellowstone Park managers calculated carrying capacity for elk of the northern herd at 7,000 to 11,700, based upon range methods used for domestic livestock. These criteria have since been abandoned for use with free-ranging, native ungulates. The concept of *economic* carrying capacity or the level of plant/animal ratios that produce the most gain in animal productivity prevailed in the early thinking. Early perceptions that elk numbers exceeded estimates of carrying capacity prompted herd reductions in the period 1932 to 1968. Douglas Houston (Houston, 1982) applied the concept of *ecological* carrying capacity – the dynamic equilibrium between native ungulates and their vegetative food base – to the northern elk herd. Based on the herd's 1968-1975 population growth curves, he estimated an ecological carrying capacity of 17,000; on 1969-1976 populations, 15,000. Merrill and Boyce (Merrill et al, 1990), using methods similar to Houston's, calculated an average carrying capacity of 15,000 elk for the period 1968 to 1988. Any number established for carrying capacity is beset with pitfalls for the unwary, since carrying capacity levels may be modified by winter severity, climate, and habitat changes.

During the workshop, 15 speakers and 112 participants addressed the subject of ungulate carrying capacity and the effects of fires, new winter range, and the proposed reintroduction of wolves.

Participants in the workshop reported the following conclusions regarding the events of the 1980s:

New Winter Range

Several speakers concluded that the increased migrations of elk north of the park boundary since about 1978 combined with mild winters probably explained the increases in both elk and bison numbers during the decade of the 1980s. New winter range

acquisitions since 1988 (Fig. 1) have received high use by elk, particularly on the new Dome Mountain Wildlife Management Area in Montana (Fig. 1). Mike Coughenour (Colorado State University) and Francis Singer (NPS) reported progress on a nutritionally based model of elk carrying capacity to predict the effects of the winter range acquisitions (and the fires of 1988).

The Fires of 1988

The large fires of 1988 are predicted to result in elk population increases – some researchers predict a large increase, others, a minor one. Monica Turner (Oak Ridge National Laboratory) and others reported on the progress of model effort to predict the effects of fire size and spatial heterogeneity on ungulate survival. The Coughenour model will predict the changes in elk population size from the fires of 1988.

Human Activities

Mary Meagher (NPS) reported the carrying capacity of bison winter ranges has been enhanced by the grooming of interior park roads. Bison move more easily to distant parts of the winter ranges on the groomed roads.

Proposed Reintroduction of Wolves

If wolves were reintroduced to Yellowstone, E.O.

Garton and others (University of Idaho) predicted 75 wolves in about 9 packs would inhabit the park's northern winter range. These authors predicted the northern elk would decline no more than 10 percent after wolf reoccupation (Fig. 3). They predicted negligible effects on elk harvests.

Mark Boyce (University of Wyoming) predicted a moderately high probability of wolf extinction if fewer than 10 wolves were reintroduced. He recommended a seed of 30 wolves. His models predicted 15 to 25 percent fewer elk and 5 to 15 percent fewer bison on the northern range after complete wolf recovery. Variance in ungulate numbers due to climatic variations should decrease; 15 to 25 wolves might leave the park each year.

David Vales and James Peek (University of Idaho) predicted slightly lower total elk harvest after wolf recovery in the Gallatin and Sand Creek elk herds. Hunter harvest must be directed primarily at bulls in heavily harvested elk herds.

Francis Singer (NPS) predicted Yellowstone Park could support the territories of 8 to 11 wolf packs and portions of the territories of another 3 to 4 packs. Wolves were predicted to kill ungulates in the order: elk > bison > mule deer > moose > pronghorns > bighorns. Wolves should have only minor impacts on ungulate distributions. Mostly adult female ungulates with very young have been observed to alter their habits when wolves are present. Coyotes are predicted to decline and red foxes to increase after wolf recovery. Visitors would see about as many ungulates after wolf recovery. Visitors would be minimally affected by some closures of a few square miles near active wolf dens from about April 1 to June 15.

Researchers utilized a wide variety of predictive techniques. To those, Merrill/Boyce added summer grassland phytomass. Predator-prey models were then constructed from knowledge from the literature of wolf densities, wolf predation rates, wolf consumption rates, and known or simulated functional and numeri-

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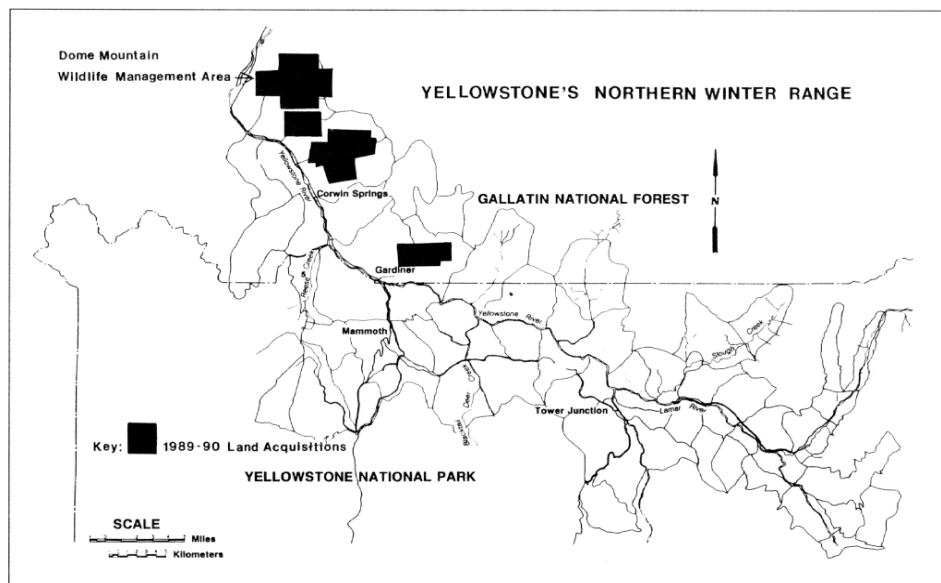


Figure 1. Winter range acquisitions north of Yellowstone National Park, 1989-90.

Bark Beetle Battle Given Historic Treatment

A fascinating historical account of the combined efforts of three government agencies to eradicate the mountain pine beetle (*Dendroctonus ponderosae*) in one particular area is contained in the recent publication, ***The Battle Against Bark Beetles in Crater Lake National Park: 1924-34***, by Boyd E. Wickman, research entomologist with the USFS Forestry and Range Sciences Lab in LaGrande, OR.

The report records the first large-scale bark beetle control project in a national park in the Pacific Northwest. It describes the relations among NPS, USFS, and USDA Bureau of Entomology personnel, how the project was organized, the ecological implications of the outbreak, and the long-term results of direct control measures.

Long-range historical light is shed on the activities of the first year (1925) – the insect situation, the main human characters involved, the recommendations from all participants in the decision-making, and the treatments administered. The 8-year "war" that ensued is covered in detail, with historical photos, memos and correspondence from old files, even cartoons of the time.

Wickman, in a section titled "The Aftermath," concedes that "hindsight is often 20/20, but it is hard not to give the beetles credit for defeating the puny efforts of the entomologists to stop the infestation." He points out that most of the lodgepole pine stands in the area of infestation were at a susceptible age for attack and that control efforts were of little avail.

"The main lesson learned," Wickman writes, "was that once a mountain pine beetle population erupts over a large area of susceptible forest type, and as long as environmental conditions remain favorable, there really is no way to stop it until almost all the susceptible trees are either killed or removed by logging."

In 1984, lodgepole pine stands in central Oregon were once again ravaged by the mountain pine beetle, Wickman notes, and by 1985 a severe outbreak covered thousands of acres and extended south nearly to the park boundary. "In 1986, beetle-killed trees were found in the northern end of the park," he writes. "We found groups of lodgepole pine being attacked by the mountain pine beetle, so we have come full circle with a new outbreak in progress."

As an epilogue, Wickman tacks on a ditty by an anonymous author that was published in 1925 in a Western Division newsletter, ***Forest Insect Investigations***, put out by the Bureau of Entomology, Stanford University. In part, it goes like this:

The Song of a Park Ranger

The bugs, they're killing the timber
They've worked for many a year,
But the entomologists prophesy
That they'll quickly disappear.

Chorus:

Oh! they ain't gwine fly no more, no more,
They ain't gwine fly no more;
But how in the ---- can the bug men tell
They ain't gwine fly no more.

For the rest of the song, see the PNW-GTR-259, available from USDA Pacific Northwest Research Station, 319 S.W. Pine St., PO Box 3890, Portland, OR 97208.

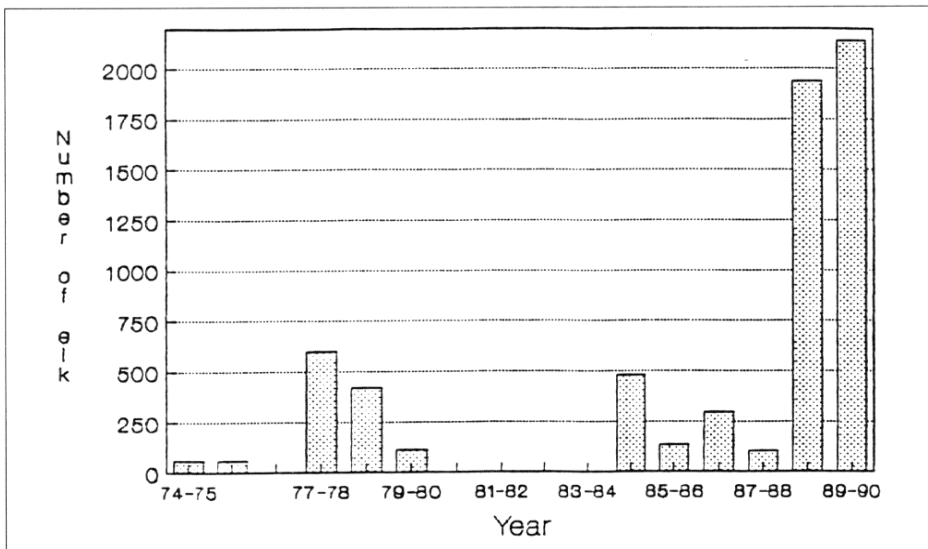


Figure 2. Maximum number of elk counted during the winter on the Dome Mountain-Stands Basin area from 1974-75 to 1989-90. Data from Chrest and Herbert (1980), Chrest and Peterson (1979), and NPS files. Missing bars indicate no data were obtained.

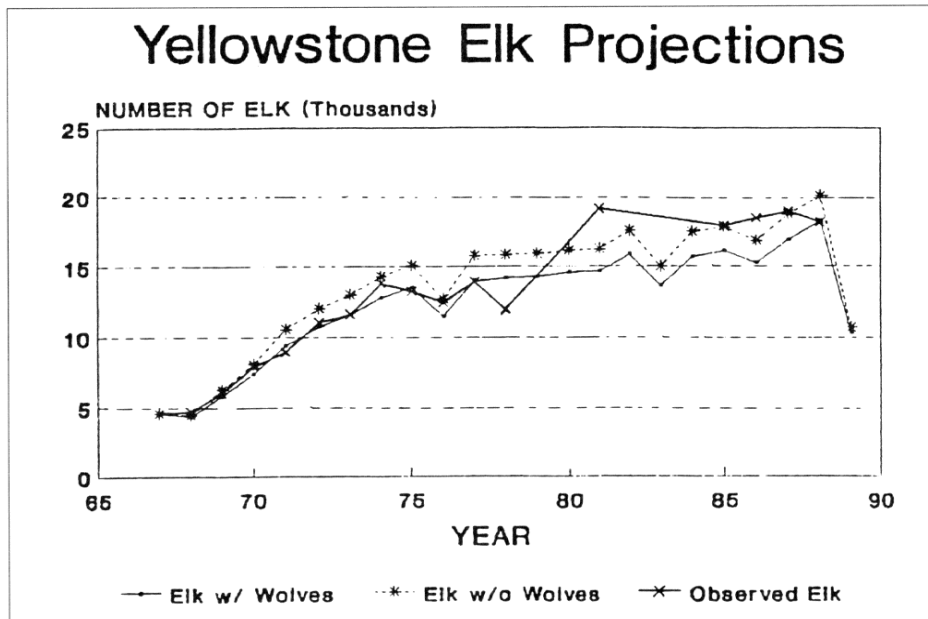


Figure 3. Slightly fewer elk are predicted for the northern Yellowstone elk herd in the presence of wolves (figure courtesy of E.O. Garton).

cal responses. Garton's model varied from the Boyce model principally in that wolf predation was apportioned by wolf social class. Vales and Peek utilized Leslie matrix and balance models. Singer, Servheen and Knight (not present) based their predictions on literature reviews, interviews and correspondence, while Koth and others (not present) used the Delphi survey method. Larry Roop (Wyoming Game and Fish) reported on the use of Pop-II models to predict effects of hunter harvests on ungulates, and Tom Hobbs (Colorado Division of Wildlife) described the interface between population and plant-based models of carrying capacity.

Conclusions

A consensus was reached that the mild winters of the 1980s were primarily responsible for recent increases in ungulate numbers. Both the fires of 1988 and purchases of the new winter ranges will result in larger numbers of elk, but winter severity will continue

to have a strong influence on elk numbers. Managers and interpreters should be prepared for the elk increases. Researchers concluded that the presence of wolves would result in <10 percent to <25 percent fewer elk and 5 to 15 percent fewer bison. The workshop participants recommended that more information be gathered over the next few years on ungulate response to the large fires of 1988. A period of accelerated data collection on ungulates and other predators should precede any wolf reintroduction.

Singer is a Research Ecologist at Yellowstone NP.

Suggested Reading

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If you have trouble "pushing things back an additional 10 million years," don't bother reading the rest of this.

A 135-million-year-old fossil found in China appears to be that of the oldest bird yet known that lived in trees and flew with agility. This is according to researcher Paul Sereno, who came up with his own entry into the "oldest known bird" sweepstakes at the October 12 (1990) meeting of the Society of Vertebrate Paleontology in Lawrence, KS. The specimen was found in 1987 in northeastern China and the Beijing Natural History Museum asked Sereno for help in studying it.

The most recent fossil find, not yet officially named, evidently followed by about 10 million years the Archaeopteryx – a ground-dwelling, toothed precursor of modern day birds that could climb trees, jump, and flap its wings but probably was unable to engage in long range flight or to live in trees.

A truly tree-dwelling bird fossil was found two years ago in Spain, dating back 125 million years, but this new report "pushes things back an additional 10 million years." The sparrow-sized bird retained some dinosaur characteristics: moveable fingers on the front edge of its wings, a lack of fusion of many of its bones, and a club-shaped end of the pubic bone that may have rested on the ground when the bird sat. But according to John Ostrom, curator of vertebrate paleontology at Yale Peabody Museum of Natural History, "it was very definitely an advanced-level bird" and showed that modern-day flying ability came about very early in the history of birds, he said.

**

The **New York Times News Service** reported in early October that "a gaping hole in Earth's protective ozone layer has again opened over Antarctica, and scientists reported on October 12 that the depletion of ozone there seemed to be nearly as severe as it was in the worst previous years, 1987 and 1989." NOAA and NASA agreed that this is the first time a severe Antarctic ozone hole has developed in two successive years, implying increasing health hazards throughout the world.

Dr. Mark Schoeberl of NASA's Goddard Space Flight Center said the minimum value of the ozone shield over Antarctica this year fell to 124 Dobson units on October 4. Dobson units are a measure of the ability of the atmosphere to absorb certain wavelengths of light, including a dangerous form of ultraviolet radiation. When the ozone layer was intact, normal readings above Antarctica reached 500 Dobson units. When chlorofluorocarbons reach the stratosphere they break apart and destroy ozone, prompting fears of an epidemic of skin cancer and cataracts for humans and damage to crops, notably soybeans.

**

Coral reefs around the world are suddenly starving and in many cases dying, the **LA Times-Washington Post Service** reported in October 1990, "because of abnormally warm seas. The news service quotes leading marine scientists as seeing this phenomenon as an early warning system for environmental degradation.

The coral reef die-off occurred three times in the 1980s and may be more serious this year (1990), biologists contend. Locales where coral reefs are "blotchy and sickly" include the Florida Keys, Puerto Rico, Jamaica, the Bahamas, Bermuda, Hawaii, and Okinawa, and most researchers suspect higher sea

temperatures as the culprit. As water heats up, the coral polyps that build the reef with their skeletal remains spit out the microscopic algae that help feed the coral and give the reef its golden, red, and yellow hues. The phenomenon is called "bleaching." Without its algal partner, the coral becomes weak and stops reproducing. After several weeks, it may die.

Robert Wicklund of the NOAA Caribbean Marine Research Center sees the reefs as "in peril and disappearing at an alarming rate." Corals in past episodes would often return to health, but there is preliminary evidence, he said, that repeated stress may make recovery more difficult.

**

The Navajo Generating Station at Page, AZ, has "contributed significantly" to a haze that periodically dims the vivid colors of the Grand Canyon, according to a committee of the National Academy of Sciences. The findings were reported in October by **Cox News Service**.

The committee added that other power plants, ore smelters, and the exhaust of distant automobiles also contribute to the problem, so that even if the best available pollution control devices were installed on the Navajo plant, the Grand Canyon's wintertime haze "would most likely be reduced, but not eliminated."

Owners of the power plant hailed the academy report as evidence of "flaws" in a 1987 NPS study, which indicated that during the winter, climate conditions favored bringing sulfurous emissions from the plant to the rim of the canyon 65 miles away, and that haze could be traced at least partly to the plant.

The NPS experiment triggered an EPA regulatory proceeding that could require the Navajo station to install up to \$1 billion worth of pollution control equipment.

Another unlikely source for an Information Crossfile item was James J. Kilpatrick, whose mid-October column on language uses and misuses contained this gem:

"The **New York Times** reported last year that a nature conservancy near Palm Desert, Calif., is doing well. It protects lizards, burrowing owls and 'raptures of all kinds.' A lovely thought, to preserve a rapture, but the sanctuary probably is preserving raptors."

Helen Lorber of the **Knight-Ridder News Service**, in reviewing Jean Auel's latest book in the "Earth Children" series (starring Ayla, who seems personally to have made every advance in prehistoric human history), makes one observation that deserves a place in these pages. Lorber objects to "the excruciating detail" in which Auel describes "the weather, flora, and fauna." She offers as an example, the following paragraph:

"Relict areas of temperate deciduous trees were maintained in certain protected areas and at the lower latitudes, with hardier needled evergreens appearing in the boreal regions to the north of them"

Lorber continues, "A certain amount of factual material is important, but Auel seems intent on including every fact she dredged up in her research." (A major source for Auel's "excruciating detail" was a paper on Paleocology of Beringia. No citation given.)

Three authors, Robin Lambert Graham, Monica G. Turner, and Virginia H. Dale, explore the dramatic and exceedingly complex changes likely to occur in the forests of the world as a consequence of elevated CO₂ and climate changes. In an article in the September 1990 issue of **BioScience** (40:8, pp 575-587), they look at the ways forests directly affect climate at the global scale (by altering the earth's albedo, hydrological regimes, and atmospheric CO₂) and at a local scale (by altering temperature, humidity, and solar radiation). They also examine forest responses at many scales. They use, as a framework, four levels of biotic organization – the biosphere, the biome, the ecosystem, and the tree, taking into consideration forest responses that cross these scales.

The article, which also is available as Publication #3476, Environmental Sciences Division, Oak Ridge National Laboratory, examines the potential forest responses to elevated CO₂ in conjunction with climate change. For each level of biotic organization (illustrated with excellent graphics), the authors discuss the potential effects on key ecological processes, how human intervention can affect those processes, and the role of modeling in elucidating and predicting forest responses. The article concludes with a discussion of future research needs.

**

In the same issue of **BioScience** (pp 558-562), Anna Maria Gillis describes an ecosystem approach to land management in a feature article entitled "The New Forestry." She considers the Jerry Franklin approach (called "new forestry"), with its claims that commodity production and preservation of ecological values are not completely incompatible, and looks at the field of response to this idea, from both proponents and critics. The consensus, she concludes, is that "much research still is needed."

A sidebar story describes the report, **Forestry Research: A Mandate for Change**, released in July by the National Research Council Committee on Forestry Research. The report calls for more research in five areas, one of the goals of which "should be creation of forest management systems that produce commodities while maintaining ecological values." The committee was particularly concerned that "the forest science community does not now have the human resources to do the research our nation requires."

**

A syndicated feature by Steve Newman entitled **Earthweek: A Diary of the Planet**, which appeared in mid-October 1990, describes how Italian officials plan to force members of the Mafia out of their remote mountainous refuge at the southeastern tip of the country and turn it into what could be the largest national park in Europe.

"Aspromonte, where caves are now used to imprison victims of the Mafia's 'protectionist racket,' would become a peaceful retreat," according to Newman. "Vacationers could wander on nature trails or explore natural science in new museums. Theoretically, 27,000 national forest guards patrol the area, but the 'Ndrangheta,' or Calabrian branch of the Mafia, is the force that controls it, and puts out forest fires. Their expulsion from the wilderness would mean the end of an era in which the efficiency of organized crime preserved nature against man-made destruction."

Fisheries and Coastal Wetlands Research, Volume 6 of the Proceedings of the Conference on Science in the National Parks, 1986, saw the light of publication just before the 1990 Conference convened in El Paso in November 1990. The 184 page document, edited by Gary Larson and Michael Soukup, is available through the George Wright Society, PO Box 65, Hancock, MI 49930-0065.

**

"Bats are integral components of all ecosystems. Everywhere you find them, they're very important to the area." Thus speaks Jacqueline Belwood of Bat Conservation International, quoted in an October 25, 1990 *Oregonian* feature section devoted to bats. The only mammal capable of powered flight and with 920 species worldwide, they form the second largest mammal order – exceeded only by rodents. They exist on almost every continent, and in nearly every country, and they eat about half their weight in insects every night. The flowers of the agave plant (source of tequila) become reproductively active only at night. Without bats, the plant's seed-set drops to 1/3000th of normal. In some areas, a decline in vegetation, infestations of harmful insects, and even climate changes are thought to be the result of diminished bat populations.

**

A strong correlation between Pacific weather conditions and the spread of fires months later in Arizona and New Mexico has been reported by two scientists, Thomas W. Swetnam (U/AZ) and Julio L. Betancourt of the USGS. R. Monastersky reports on their findings in Vol. 138 of *Science News* (p. 132). The Tucson-based scientists sifted through fire statistics back to 1905 for national forests in the Southwest and compared them with wintertime fluctuations in the Southern Oscillation – a record of air pressure over the central Pacific that can serve as an indicator for El Nino (ocean surface water warming in the central Pacific) and La Nina (when surface water in the central Pacific turns unusually cold for a year or more.)

The most extensive forest fires in the southwest have struck predominantly during La Nina; relatively minor southwestern fires have developed during El Nino periods.

While the correlation is not perfect, a chart superimposing the Southern Oscillation on a record of areas burned leaves little doubt as to a relationship – one that Swetnam says can prove useful for officials planning prescribed burns. "If we have a La Nina situation in winter months," he asserts, "I would say caution is advisable."

With the hope that there is no gruesome coincidence in the fact, we report here that Halloween 1990 was the 61st anniversary of the Archeological Protection Act. May it escape all hobgoblins and enjoy many many happy returns!

Most oil spill cleanup efforts are doomed to failure, and even major oil spills produce environmental and socioeconomic consequences that are "relatively modest and, as far as can be determined, of relatively short duration."

This is the conclusion of James Mielke, author of *Oil in the Ocean: The short- and long-term impacts of a spill*, 90-356 SPR, available from CRS, Library of Congress, as reported on page 371 of the October 19, 1990 issue of *Science*.

Researchers contacted by *Science* tended to agree with Mielke's assessment, but added the proviso that oil stuck in quiet coves and marshes can persist at toxic levels longer than in areas exposed to wind and wave. Still, they say, recovery begins in years, not decades.

**

NAPAP (the National Acid Precipitation Assessment Program) became history on October 1, 1990. The 10-year, \$535 million study of acid rain thudded to a 3-volume conclusion that acidic pollutants have changed the landscape in certain especially vulnerable regions, and predicts where and when future benefits might accrue from tightened controls on fossil-fuel emissions.

Science News (September 15, 1990, p. 165) quotes a Natural Resources Defense Council spokesperson (Deborah A. Sheiman):

"We knew in 1980 what they're telling us now: What causes acid rain, how to control it, what are the effects." By "studying the problem to death" she charged, NAPAP "became a convenient excuse for political inaction."

Christopher Bernabo, NAPAP's first director and now a Washington DC consultant disagrees. He thinks NAPAP's most lasting legacy will prove to be organizational. The focus required for the program, he says, not only taught government agencies how to collaborate effectively but also showed them how "to make the transition from curiosity-driven research to policy-making research."

**JAMES M. RIDENOUR, Director
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The September/October 1990 issue of *National Parks* magazine describes in historical detail how the U.S. Army Corps of Engineers is beginning to "undo its own damage" to the Florida ecosystem. The drainage system built by the Corps – some 1,500 miles of canals and levees, left Florida with a legacy of polluted and declining water supplies and a dying ecosystem in Everglades NP. "Now," says author Vicki Monks, "having spent hundreds of millions to drain the Everglades, the Corps has enthusiastically agreed to spend hundreds of millions more to undo some of the damage."

Concern now is focused on the specific designs for restoration of natural water flows in the Shark River Slough and the Taylor Slough, the two main sources of water for the park, Monks writes. "Last year, Congress approved legislation expanding the park by 107,000 acres to include all the Shark River Slough. The Corps was directed to re-engineer the water supply to provide some close approximation of natural patterns."

Chief of Engineers General Henry Hatch is quoted as follows:

"Embracing and promoting our environmental ethic will change the way we do our traditional business," and he further pledges the agency to strive toward becoming "the environmental engineers of the future."

**

In *Science News*, September 22, 1990, Richard Monastersky reports on two paleontologists – William A. DiMichele and Scott L. Wing – who are working in the recesses of the Smithsonian Museum of Natural History on ancient swamp research. How did life survive 315 million years ago in the face of climate changes (DiMichele's study area) and again at about 55 million years ago (Wing's study focus.)

The article describes their findings in some detail, and then comes up with what Monastersky calls "an unsettling message regarding the threat of a global warming." If the planet warms as many scientists predict, temperature and rainfall patterns could shift faster than ever before, placing unprecedented levels of stress on the environment. This is the crux of what the researchers think they have discerned in their "tales from the swamps" of the past.

"If biological communities have a certain threshold for climate change, as DiMichele and Wing suggest," writes Monastersky, "ecosystems such as the boreal forests might show no signs of weakness until stress crosses that threshold and the communities abruptly collapse."

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"After more than two decades of silence, the cliffs of the Columbia River Gorge are again echoing the shrieks of the peregrine falcon."

Thus opens a story titled "Back in the Nest," by Eric Goranson of the Portland *Oregonian* staff, as it appeared in the October 18, 1990 issue of the newspaper.

"Reduced to only 27 known pairs of birds nationally in 1975," Goranson reports, "and with no known wild breeding pairs in Oregon as recently as 1985, the falcon is being considered for removal from the endangered list in some areas of the country. Today the U.S. count is estimated to be 1,500."

Redwood NP Geologist Reports On Gravel Bed Rivers Workshop in Italy

*Editor's Note: In September (23-28) 1990, Mary Ann Madej, Redwood NP geologist, and Thomas Lisle of the USFS presented an invited talk on "Spatial variation in armoring in a channel with high sediment supply" at a fall workshop held in Florence, Italy. Following is Madej's report on the conference, which she attended on an award from the Horace M. Albright Employee Development Fund. The paper she gave will be published by John Wiley and Sons in a book entitled **Gravel Bed Rivers**.*

By Mary Ann Madej

Environmental consequences of natural and anthropogenic changes in rivers have become areas of national and international concern. The Third International Workshop on Gravel Bed Rivers was held Sept. 24-28, 1990, in Florence, Italy to address river management problems and their underlying causes. The theme was "Dynamics of Gravel Bed Rivers"; 92 participants from 17 countries, including New Zealand, Japan, Switzerland, Israel, Germany, Iran, Somalia, and Czechoslovakia attended.

The 47 papers were distributed beforehand, and after two or three short presentations at each session, an hour-long discussion period allowed workshop participants to thoroughly debate controversial issues. Video sessions provided vivid illustrations of problems and studies in other countries. Discussion comments will be published with the conference papers.

Italy made a fascinating setting for the meeting, particularly for a scientist used to augmenting short-term records with sometimes ambiguous field evidence. I was startled to read accurate accounts of flooding from November 1333 (when the Arno River floodwaters overtopped the altar in the Duomo in Florence), and to see a landscape that has been cultivated intensively for at least 2000 years.

Post-conference field trips to research sites further enforced the urgency to deal with erosion and sedimentation in order to preserve natural and cultural resources. For example, soil loss from vineyards north of Florence was measured at 2.33 mm/yr (equivalent to 9 inches of soil erosion in 100 years). Such high erosion rates surely will influence long-term soil productivity, stream sedimentation rates, and the economic viability of a region.

Large sand bed rivers such as the Mississippi have been studied for centuries, but less attention has been focused on gravel bed rivers, which differ from sand bed rivers in several ways. Gravel bed rivers have riffle/pool bedforms rather than ripples and dunes. Sediment moves only at moderately high to high flows, and sediment transport dynamics are different. Gravel bed rivers tend to be steeper, are located in more rugged terrain, and are more stable in channel cross-sectional shape. Over the last decade interest in gravel bed rivers has grown, due to increasing pressures on upland areas in both developed and developing nations.

Rivers are critical for maintaining riparian and aquatic ecosystems and for influencing land management activities. They are used for recreation (swimming, boating, fishing, hunting, hiking, birding), navigation, water supply, power generation, sand and gravel supply, wildlife corridors, and flood routing. Human activities such as road construction, flood control, logging, and urban development have caused reservoir

siltation, sedimentation in navigation lanes, bank erosion, water quality degradation, water depletion, pollution by toxic wastes, and modifications in flooding frequency.

Concomitantly, development is encroaching on many areas that are susceptible to erosion and sedimentation problems, such as landslide prone sites. Catastrophic dam bursts, debris torrents, and floods also have highlighted the need for studies of gravel bed rivers.

River research (fluvial geomorphology) is basically a study of the nature of change through time and space. Discussions focused first on the nature of environmental change. How do we separate natural versus artificial change? Do we act now or later to reverse change? To what extent and at what scale do we act? How can we restore or conserve resources? As we try to understand implications of global climatic change, our knowledge of watershed responses to past climatic changes will help answer these questions and guide policy decisions.

Specific field studies came next. Erosion models and case studies of sediment yield incorporated remote sensing, GIS, and field documentation to evaluate short- and long-term soil loss from forested, logged, and cultivated areas. Steepland processes discussed during the conference included debris flow initiation and deposition, alluvial fan formation, and floodwaters with extremely high sediment loads generated from mountainous areas. Debris torrents can devastate highways, railroads, buildings, and vegetation. Several presentations stressed the necessity of interpreting debris flow deposits in order to understand debris flow mechanics and help predict future damage.

Many papers discussed the transport of sand and gravel in braided and meandering rivers. Research concerns included quantifying when sediment is moved, how far it moves, and what size and shape particles move. Painted rocks, magnetic tracers, and even radio transmitters have been used to track gravel movement. In some gravel bed rivers the dominant

size of transported sediment is actually sand. Innovative techniques to measure bedload and new statistical analyses were presented. Gravel size distribution influences salmonid spawning success. An input of fine-grained silts and sands can either penetrate spawning gravels or form a seal on streambeds, to the detriment of aquatic life. Streambeds consolidate (or become more compacted) through time, and this may affect spawning success as well.

Coarse gravel layers frequently form over finer streambed material (an armor layer). This layer may protect underlying streambed sediment from erosion until flows become quite high. How this armor forms, its spatial variability, and its importance in controlling bed mobility were explored. Bed mobility also influences the survival of salmonid eggs and juveniles. In Redwood Creek in north coastal California, severe erosion and sedimentation caused widespread channel instability in the past, threatening old growth redwood trees along the river and salmon population. Dr. Thomas Lisle of the USFS and I presented results of studies in Redwood NP, assessing channel stability, bed mobility, and armoring.

Channel stability affects both natural and cultural resource. Causes of bank erosion were debated. New solutions to bank erosion problems (besides unsightly and locally damaging riprap) were presented. Gravel mining can initiate channel instability (bank erosion, channel shifting, and channel downcutting). Erosion control structures have been used to stabilize river channels in Europe since the 1850s. The lessons learned from their successes and failures can help guide our decisions on the use of modern structures.

Long-term changes in river systems were explored. The record of flooding history can be extended through interpretation of floodplain sediments. Some upland rivers show significant channel pattern change, whereas others under similar geologic and landuse conditions remain stable. The main factors influencing channel change are landuse and climate; however, streambanks may erode and meandering bends may



Old-growth redwood trees along Redwood Creek in Redwood National Park.

Technical Writing As a Tool – An Art

*Editor's Note: In the spirit of celebration of **Park Science's** 10th anniversary, this article by Jim Wood is reprinted. When it first appeared, in the Spring 1983 issue, my Editor's Note was a single word: Amen! I echo that sentiment as we reprint this excellent and instructive piece. At the same time we mourn Jim's recent resignation from the NPS (where he has for years been the technical editor, working out of the Southeast Region) in order to accept a job with the USFWS in Atlanta. He will be sorely missed!*

By Jim Wood

The need for high quality in research papers has never been more evident than in today's fast-paced, complex technological age. Our minds boggle from the accelerating expansion of research and all the publications resulting from it. The practicing scientist, manager, or administrator has only limited time to keep abreast of the voluminous literature. His problems multiply and intensify when that literature is verbose, vague, and boring. He deserves to read articles that are technically sound, informative, well-organized, and a pleasure to read. He must be able to grasp information and ideas at a single reading, without having to re-read sentences or puzzle over ambiguities.

Although I believe the writing of many NPS scientists is of high quality, as an editor I have seen no manuscripts that could not be polished and improved. Some have been prepared so poorly and in such careless, sloppy language that they fell far short of the high standards on which the Service must insist. It was impossible to judge their scientific worth until they were translated into reasonably acceptable English.

Some of the best (and some of the poorest) written English I have seen is the work of technical men and women – biologists, geologists, social scientists. Technical writers, whether they realize it or not, start with an advantage. Their basic material is concrete facts and events. Their main object is to describe such and show the relationships between them.

In my judgment, the best technical writing is being done by persons at the top of their professions. They have done important work, understand its meaning, and write about it with confidence. They are bold and sure enough to write simple, direct English.

Too many others, who lack experience and assurance, tend to write with an uneasiness that leads

to fog. They smother their meaning in qualification and jargon. Still others are so engrossed in their work that its "special language" has become second nature to them. They overlook how awkward and puzzling this gobbledygook can become when allowed to clot on paper.

The scientist who is sure of him/herself includes, of course, qualification and specialized technical terms when required. But s/he also recognizes the surplus that can be safely shed. This is an important part of wisdom and essential to clear communication.

I find it ironic that:

(a) Most scientists do very well in oral communication, talk simply and clearly, and can explain to a layman what they are doing. But once they begin to write, they shun simple English and slip into an odd jargon they consider "traditional" and "safe." They are afraid that if they did otherwise, their writing might seem "unprofessional." It is *never* unprofessional in the sciences to make oneself clear!

(b) Although many technical and professional people are poor writers, they read no better and are no less confused by fog than laymen. This is easy to judge from the lively oral discussions often printed following the scientific papers of technical meetings. Many scientists habitually skim the articles, and then read closely the oral discussions!

All the foregoing doesn't mean scientists should write their reports for grade-schoolers. Neither should they write their papers as "all things to all people." What I want to emphasize is – *any piece of writing should revolve around the intended reader.* The report should be related to the reader's experience. It should prepare him for what he is about to read. It should be presented in a rational, logical manner and enable him to gain facts and their relationships in the shortest possible time.

Any scientist who writes a paper has spent time gathering facts and contemplating their meaning. The interpretation of meaning is usually the most important part of the paper. The author owes it to the reader to make clear the meaning he has been able to draw from the facts – *without* neglecting to underline points that are still unclear or unsolved. This is especially important for scientists working for public land management agencies like the National Park Service. They have a clear obligation to park managers charged with the stewardship of these lands.

persistence of fine-grained sediment on aquatic life and stream dynamics.

Several of the new erosion and sediment modeling techniques and analyses described will be incorporated into the Redwood NP monitoring program. Our flood history project will benefit from new approaches to floodplain sediment analysis. I became convinced of the importance of incorporating climatic change monitoring into process studies in park watersheds.

Finally, it is important to note the social and economic implications of attending such a smearing. Europe is no longer a step behind the U.S. in river studies. Many papers made it clear that Europe, Japan, and New Zealand are devoting the money and energy needed to solve river management problems. Formation of a unified European Community in 1992 will affect science and resource management, through side-ranging government policies and a free exchange of scientists. U.S. scientists must stay abreast of international advances to maximize our efforts.

When a scientist writes for those outside his field he should take care to avoid or explain technical terms that are not commonly familiar. In writing for people within his own field, he should review his technical writing self-critically and ask himself: Am I using these words to express or to impress? Am I using them because they are necessary to make my ideas clear, or am I using them merely to signal that I am an expert?

Four guidelines will help:

(1) Arrange the material logically. Organize your writing in logical order. Don't begin your report in unknown specifics rather than familiar basics. Most audiences regrettably are still more familiar with yards and acres than with meters and hectares. If you need to use both systems, ordinarily you give the familiar one first, then use parentheses to convert to the other system. (*Ed.'s note: This no longer applies to **Park Science** articles. Our readers are comfortable with the metric system.*)

(2) Prefer the active voice. Technical writers should make a special effort to avoid a monotonous series of passive constructions. Active ones are shorter and more readable. Example:

PASSIVE: The melting point of the alloy was lowered 50ThTdegrees by adding 10 percent of aluminum.

ACTIVE: Adding 10 percent of aluminum lowered the melting point 50 degrees.

(3) Don't make nouns out of good, strong "working verbs." Making nouns out of verbs tends to smother the meaning of sentences. Example:

SMOTHERED: Authorization must be received from the Research Director before utilization of new methods can be incorporated in this project.

IMPROVED: The Research Director must authorize new methods before they are used in this project.

(Why not "utilize"? Isn't that the verb form of "utilization"? Yes, it is. But "use" is shorter, crisper, and less stuffy.)

The main trouble with smothered verbs is this: Anytime you change a working verb to a noun, you must add another verb to complete the sentence. Also, you can see from the above example that smothered verbs and passive constructions frequently go together. In fact, they are almost inseparable. If you can "unsmother" a verb, and at the same time change a passive to an active construction, you'll cut sentence length by a third and increase the chance for interest and understanding.

(4) Be concise – cut out excess baggage. Technical writers should strive to eliminate unnecessary complexity by reducing sentence length. Example:

ORIGINAL: Comparison of data obtained with these paints using Barco with those using Lenol revealed that use of Barco solvent slowed the drying appreciably (approximately doubling the time in most instances) but had very little effect on the viscosity characteristics obtained.

REVISION: The data showed paints using Barco were no more viscous than those using Lenol, but dried only about half as fast.

These guidelines do not cover every possible "poor writing" situation – just a few of the more common ones. For those who wish to learn more, I suggest this paperback: **Writing with Precision** by Jefferson D. Bates; published by Acropolis Books, Ltd., Washington, DC 20009; \$6.95.

In these days, more than ever before, the reading time of a scientist is precious. Few of them like the task of writing. But writing is the chief means (and permanent record) of handing on what they have learned.

Remember, write for the reader, not for the filing cabinet! And most of all, write to *inform* – not to prove that you're smarter than your readers!

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evolve naturally through time, even without climatic or landuse changes.

In concluding remarks, Dr. Luna Leopold, (son of Aldo Leopold), cautioned us to keep our sights wide. As we focus narrowly on individual problems, he urged us to keep in mind the broad questions of river dynamics, climatic change, and landscape evolution.

Several problems of direct concern to Redwood NP received conference treatment. For example, gravel mining and bank erosion locally threaten park resources. Channel stability is important to the survival of Redwood Creek aquatic life and old growth redwood trees. Changes in bank erosion rates and locations or in gravel transport patterns can be detrimental to these resources. A highway construction project located in a headwater stream adjacent to Redwood NP delivered a large amount of fine-grained silts and sands to pristine reaches of the park farther downstream. Monitoring techniques presented at the conference gave me insights on how better to measure the impacts and

Olympic NP Mountain Goat Removal Project Subject of Risk Assessment Report

By Seth Tuler and Chuck Janda

Mountain goats were first introduced to the Olympic Peninsula by sport hunters in the 1920s. In the 1970s, studies by the NPS and the University of Washington found that the original 11 or 12 had increased to one of the highest density populations in North America. In 1983 the park counted an estimated 1200 goats on Olympic Peninsula; about 1000 were in the park.

Disturbances from these exotic animals have been documented for portions of the unique ecology of Olympic NP (*Olympic National Park* 1987). They include erosion problems created by wallows, trails, and dusting, disturbance of endemic and preferred forage species, and alteration of the structure and productivity of alpine and subalpine ecosystems. As goat populations and human interest have grown, potentially hazardous encounters between salt hungry goats and curious visitors also have grown. (*Park Science*, Fall 1981, p.5).

To prevent further damage to the sensitive high country, Olympic NP began an experimental program to rid the park of mountain goats in the early 1980s. Various techniques were tried, ranging from backcountry operations to sterilizing goats to the capture of goats in drop nets and foot snares. In 1988, after a 10-year review process, Olympic NP began a live-capture and removal program, requiring innovative and difficult activities in some of the park's most remote and rugged backcountry.

In brief, a pilot and "gunner" perform high risk helicopter flights to identify, select, pursue, and capture goats. After goats are darted or netted, the gunner must alight from the helicopter, restrain ("bag"), and secure the goat to the helicopter. The animal is then flown to a staging area at Hurricane Ridge and transferred to another agency (such as the Washington Dept. of Wildlife) for release into native populations elsewhere. (The sequence begins with preparations of personnel and equipment, and proceeds to "fly-out," search and selection, capture and restraint, medical assessment and preparation, goat transport, crew recovery, flight-in, demobilization, and postcapture tasks.)

Multiple goat captures may occur during one day's activities. In 1989 the average number of captures per day was six. Successful completion depends on effective, safe, and reliable human and equipment performance at all times.

The program has been performed with high degrees of safety for project personnel despite the many risks they face. Ranger Rich Olsen has been instrumental in the design of special project activities and development of unique equipment and protocols. However, the numbers of goats captured have been smaller each year. In 1988, 80 goats were captured; in 1989, only 67. Some of the goats die from stress induced complications or bones broken during capture. In 1988 the mortality rate was 9 percent; in 1989, it was 19 percent. Risks to both personnel and goats have risen over time. "The general impression was that the goats were

improvement of safety and performance in similar tasks, leading to identification of methods that can improve safety, reliability, and performance.

The social sciences have devoted much attention to individual, group, and organizational behavior, and they provide a useful perspective from which to assess and improve safety. Task requirements of complex helicopter flights, difficult capture of goats from the air, and handling of goats on rugged terrain combine with social factors that influence the capabilities of personnel to operate safely and reliably for intensive periods during the summer. The combination of these specifics creates physical and social hazards for personnel.

While humans apparently are capable of completing complex tasks in difficult environments, the evidence shows that humans also are variable in their capabilities. The literature suggests that human variability can interact with task requirements and technical components in such a way that accidents and mishaps occur. The research has identified a number of factors that contribute to variability in human behavior and decision making—factors that may be rooted in the physical, physiological, or social characteristics of individuals and their work environment. Several important issues were reviewed, including (1) individual characteristics such as decision making and judgments, attitudes and motivation, mental workload, stress, and fatigue; (2) group characteristics including decision making and stress, and (3) organizational characteristics such as constraints on behavior, hazard management, and training.

As tasks and interactions of machines and people become more complex and the situations in which they must be performed become more difficult, the likelihood of accidents grows. Any person, regardless of skill and experience, can contribute to, or cause, an accident at any time. To accommodate the always present possibility of human error, systems should be designed to be "goof proof" and provide buffer zones that mitigate potentially dangerous consequences of mishaps and accidents. Systems that push the bounds of human and mechanical capabilities are also pushing the luck of those involved.

The specific requirements of each stage of the task can create a complex and dangerous set of activities that is not "goof proof." For example, social factors can create sources of stress and high workload, lead to

Systems that push the bounds of human and mechanical capabilities are also pushing the luck of those involved.

in less accessible areas of the park, they were harder to get to, and we were forced to take greater risks with the animals and staff in order to get them." (Chief Ranger Chuck Janda, from *Animals*, p. 24). As a result of the concern for both personnel and goats, critical reviews have been done in June and July each year prior to the next season of live capture.

Here, we summarize the results and implications of two program reviews completed in spring 1990. The first, a report on the social factors that contribute to risks, was prepared by the NPS/CPSU at U/ID. We also describe the results of a review by the Interior Department's Office of Aircraft Safety.

A Social Risk Analysis Of Olympic NP Mountain Goat Removal Project

In the winter of 1990, the U/ID/CPSU was asked to prepare a report on the "social risks" of the Olympic NP Mountain Goat Removal Project (Machlis et al 1990). In the report, "social risks" refers to those caused by interacting personnel in the project and the social environment in which they work. The report is based on information collected by a review of relevant literature on social risk and aviation safety. It provides a review of the task of mountain goat removal from Olympic NP and a summary of social science research relevant to

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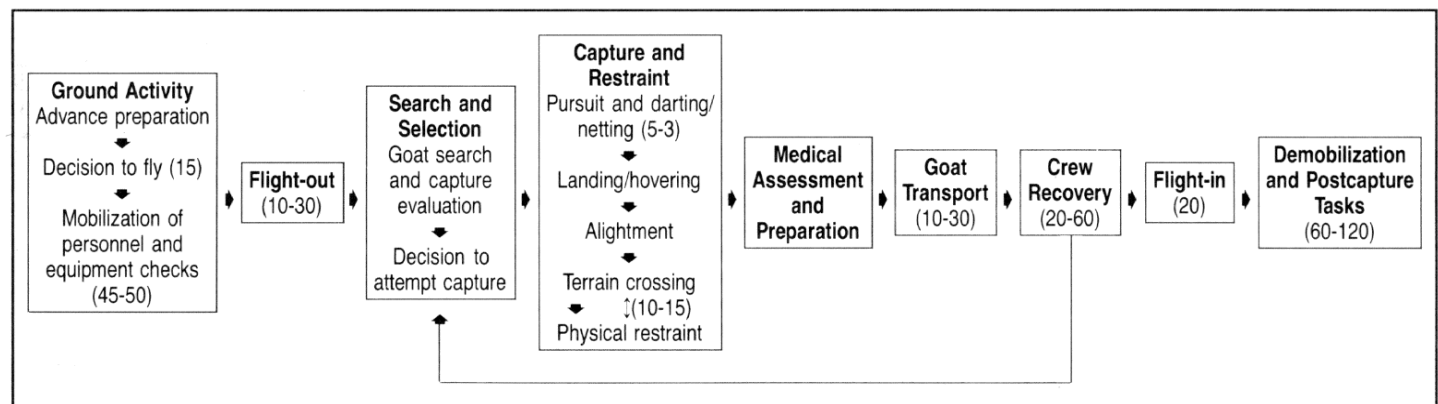
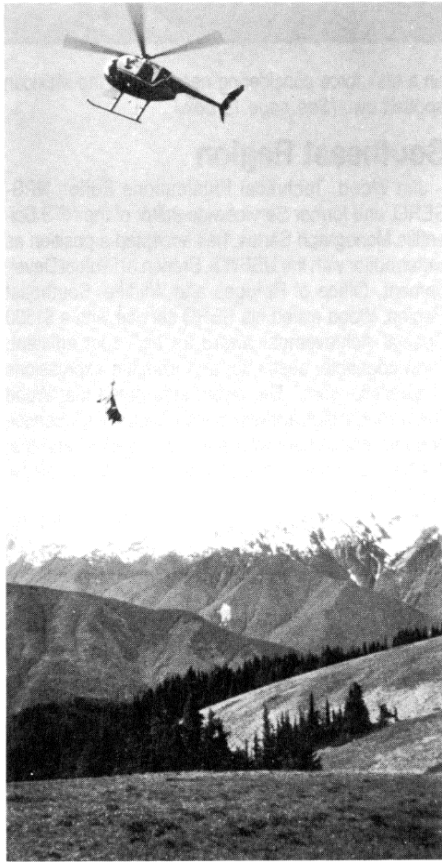


Figure 1. Stages of the technical task (minutes)



Recently captured mountain goats arriving at the staging area of Hurricane Ridge. (Olympic Natl. Park Photo by Janis Burger)



Removing the special carrying sling from a mountain goat before transport by the WA Dept. of Wildlife. (Olympic Natl. Park Photo by Janis Burger)

The authors presented these recommendations to park personnel at a May 1990 workshop.

Expanded Applications

The review of social risk factors in the Olympic NP project has importance for other NPS programs. While specific activities and characteristics of the task at Olympic are unique, the objectives of wildlife translocation and removal are common to a number of programs in the U.S. and abroad. Deer have been the subject of translocation and removal programs in Florida, Big Bend NP, and New Zealand; wild horse and burro removal has taken place at Grand Canyon and Death Valley, and big horn sheep operations occurred at Lake Mead and in Idaho. Common features have included use of dart or net guns, helicopters, specialized restraint techniques, decision making and judgment difficulties, and the interactions of individuals and organizations. Many of the social factors that influence risk and the hazards faced by personnel also are similar. Thus, the perspective used in this report and the analysis of social risk factors can be usefully applied in a much broader context.

The Office of Aircraft Safety also reviewed the project in the spring of 1990. While they had been informed of the project during its early stages in 1988, the OAS had never formally reviewed it for safety. In January 1990, an OAS Operational Procedures Memorandum (#90-5) was issued that prohibits, because of their dangerous nature, certain types of helicopter flight maneuvers: toe-in landings, single-skid landings, or step-out landings, unless prior written exemptions are obtained. The performance of the mountain goat removal project requires the use of toe-in and single-skid landings for almost all goat captures. These are landings that require full power to be maintained and during which the helicopter is not completely at rest on the ground.

In addition, although they had allowed the program to continue for two years, the OAS now believes that the helicopter flights are among the most dangerous it has seen in federal aviation programs. The outcome of the OAS team's review was not to provide exemption for such landings during the summer of 1990. This required cancellation of the project for that summer.

Future Plans

Termination of one-skid landings essentially elimi-

nates live capture as an option in removing Olympic's remaining goats. While other capture methods are available, none has proven workable in terms of effective rate or reasonable cost.

Efforts in the summer of 1990 focused on completing field work on vegetation impacts, primarily along the park's eastern periphery where endemics occur in relatively high concentrations. Another goat census also was conducted. The total population on the Peninsula now is calculated at 389 plus or minus 106. This is a substantial decrease from the 1,175 plus or minus 171 counted in 1983. The live capture program can be credited with only a portion of the decrease. Park personnel believe environmental factors such as abnormal temperatures and snowpack may have had at least an equal impact.

An EIS is now in preparation. Currently only two alternatives are being considered: terminating all goat removal operations and allowing the population to return to pre-removal levels, or eliminating the remaining goats by shooting. The latter alternative will also propose making the entire park goat-free. An earlier Environmental Assessment required a goat-free core area and a 50 percent reduction in the subpopulations along the park's east side. The abundance of endemic vegetation in this area precludes goat control as an effective option in protecting these plant communities.

Regional, if not national, public interest is expected to run high once the draft EIS is distributed. While the park has long maintained a running dialogue with animal activist and sportsman groups, shooting remains an emotion-charged issue in spite of broad agreement that goats have no place in Olympic's otherwise natural environment. A classic case history is thus about to take another unpredictable turn, with no absolutes and no "right" answers.

Tuler is a research assistant with the NPS/CPSU at Clark University in Worcester, MA; Janda is Chief Park Ranger at Olympic NP.

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difficulties in interpersonal relationships, and influence organizational planning. Three important levels can influence and shape performance:

- (1) individual factors, including "subculture" attitudes and personal characteristics;
- (2) interpersonal factors, including group planning activities and communications, and
- (3) organizational factors, including liaison among agencies and agency mission requirements.

Hazards to individuals result from failures in goat capture and removal tasks (e.g. technical failures, human errors, or mismatches between demands and personnel capabilities). Two principal types of hazard to personnel in the mountain goat project are:

- (1) physical injuries, including back pain, abrasions, sprains, fractures, accidental drug overdose consequences, and death; and
- (2) psychological, social, or economic dislocations such as a loss of confidence in management or one's peers, loss of wages or career opportunity, loss of self-image, impacts on one's family, stress, and anxiety.

Our analysis of the social science literature and the task suggested that specific changes might be useful to enhance safety, reliability, and performance. Suggestions for improving safety and performance were of four types:

- (1) altering the task to reduce social risk factors;
- (2) altering the social environment to reduce social risk factors;
- (3) monitoring social risk factors associated with the task, and
- (4) additional options, such as the role of training.

Alaska Region

North Pacific Salmonid Enhancement Programs and Genetic Resources: Issues and Concerns (see Publications, p. 19 this issue), documents and evaluates the effects of fish hatcheries on wild salmonid fish stocks in all states, provinces, and countries bordering the North Pacific Ocean. The authors, who are with the Arctic Environmental Information and Data Center at U/AK, Anchorage, paid particular attention to prediction and mitigation of probable genetic and wild stock over-harvest effects with expansion of the Sikusuiqa Springs chum salmon hatchery on the Noatak River in NW Alaska.

Ross Kavanagh, ARO Regional Fishery Biologist, administered the report through numerous drafts and extensive peer review over an 8-year period. The careful reader will note resource management connotations beyond the field of fisheries. Copies of the 250-page report, including an 80-page annotated bibliography, may be had from the ARO Chief Scientist or the NPS National Publications Coordinator in Denver.

* * *

Three Alaskan Parks now have new research biologists: Kurt Jenkins from South Dakota State U to Wrangell-St. Elias NP, Jeff Kaye from Yosemite NP to Denali NP, and Jim Taggart from UC/Santa Cruz to Glacier Bay NP.

* * *

Three new resource management specialists in Alaska are James Benedict (Denali), Ken Faber (Gates of the Arctic) and Bill Route (Wrangell-St. Elias).

* * *

Dale Taylor was one of three MAB High Latitude Ecosystems directorate members attending a Northern Sciences Network meeting in Raviemi, Finland, Sept. 27-Oct. 1, 1990. Representatives from Finland, Norway, Sweden, Canada, USSR, Denmark, and France discussed international networking, long term ecological research and monitoring, sustainable development, and status of biosphere reserves in various countries.

* * *

In the fall of 1990, Layne Adams gave invited seminars at Texas A&M U and Colorado State U on his predator/prey studies, done at Denali and Gates of the Arctic.

* * *

Victoria Harmon recently joined the Division of Natural Resources GIS staff. She has a BA from U/CO and an MA in remote sensing from U/IL in 1989. While employed at the Army Engineers' Construction Engineering Research Lab in Champaign, IL, she was involved in development, documentation and testing of GRASS software and applications projects using GRASS.

Southwest Region

Buffalo is collaborating with Ozark National Scenic Riverways in the Midwest Region to develop an Operations and Conceptual Research Plan (O/CRP) for the Ozark Uplift biogeographical region as one of the 11 areas to participate as a core research area for determining global change effects, starting in FY 1991 or 92. A workshop was held in early September to select the site from which the project coordinator will work, to prepare the position description for the coordinator, to

develop the O/CRP, and to link with researchers in the area for this initiative.

* * *

Work is proceeding to evolve the Capabilities and Interest Statements (C/ISs) for Big Bend, Bandelier, and El Malpais for further consideration by the Servicewide Global Change Program. Meetings were held in August and September to foster a joint effort among researchers and park staffs toward participation in this program in FY 1992 or 93.

* * *

Staff members of the Region's Division of Natural Resources Management and Science prepared papers for the George Wright Society's El Paso meeting in November on the following topics:

- an analysis of the high priority projects enumerated in SW Region park RMPs in the early 1980s compared to those in the RMPs of the late 1980s as to how many have been funded and/or completed fully or in part;
- an assessment of Integrated Pest Management progress in SW Regional parks in the 1980s;
- pesticide levels in selected NPS areas; and
- A computerized method of counting wildlife numbers using video tape recordings.

* * *

A Geographic Information Systems (GIS) open house was held Sept. 1, 1990, in the Regional office to inform management and SWRO non-specialists of the Region's progress in GIS and to demonstrate the two GIS systems (EPPL7 and GRASS) being used. Substantial data bases are operational for Big Thicket, Big Bend, Bandelier, and Padre Island. Data bases are being formulated for Lake Meredith, Buffalo, Capulin Volcano, El Malpais, and Hot Springs. The use of a read-many write-many optical disk device has greatly simplified storage and access of images and appears to be the technology of the future.

* * *

SWR continues to be active in Integrated Pest Management programs. IPM inspections were made in 24 percent of the SWR parks during the past FY. These inspections also provided opportunities to hold onsite, practical training for IPM coordinators.

* * *

An attempt to control water hyacinth with an agricultural vapor flamer at Jean Lafitte NHP&P showed hyacinth to have considerable resistance to heat. Additional experimentation with liquid torches may be conducted. Because some park areas cannot use open flame for weed control, SWR has purchased equipment to develop a portable hot air generator.

* * *

Cooperative efforts among the SWR, USFS, and the Animal and Plant Health Inspection Service for gypsy moth detection trapping did not show any sources of infestation at NPS sites in Arizona or New Mexico.

* * *

NPS and USFS have made a cooperative effort to classify hazardous trees in SWR parks. Actual work began in October 1990, and park employees trained in this program may be available for assistance to other parks and Regions.

* * *

SWR continues to cooperate with the USFWS in protecting endangered plants and animals and serves

on a task force considering needs to list the Mexican spotted owl. (See page 18 box.)

Southeast Region

Jim Wood, Technical Publications Editor, NPS-SERO, and former Servicewide editor of the NPS Scientific Monograph Series, has accepted a position as writer/editor with the USFWS, Branch of Project Development, Office of Refuges and Wildlife, Southeast Region. Wood exited his SERO service with a \$1500 Special Achievement award for his "cost efficient, knowledgeable, aesthetic, and valuable expressions of scientific work." The award also noted that Wood "has brought high acclaim to the National Park Service and the researchers who serve the agency" and that "he has performed these services and duties to all in a spirit of altruism."

Wood began his new duties with FWS on Nov. 19, 1990.

Ecosystem-Based Research

Reorganization of the SER office of the Deputy A/RD for Science and Natural Resources will more fully support an ecosystem-based research program. Three divisions have been established under direction of Regional Chief Scientist Dominic Dottavio: (1) Natural Resource Management, (2) Coastal and Marine Ecosystem Research, and (3) Terrestrial Ecosystem Research.

Rick Dawson, chief of the natural resource management division, is responsible for the Region's resource management planning, minerals, oil and gas, GIS, endangered species, wildlife, integrated pest management, air quality, water quality, vegetation management, publications, and social science.

Gary Hendrix, chief of the coastal and marine ecosystem research division, and Susan Bratton, chief of the terrestrial ecosystem research division, are responsible for administering research in their respective areas. This includes preparation of ecosystem research plans, inventory and monitoring proposals, and proposals for WASO special initiatives; supervision of the Region's field scientists and research projects; and development of cooperative research programs.

Research positions supported by Regional funds will investigate questions of regional scope as well as park-specific issues. The field scientists are assigned to either the chief of coastal and marine ecosystem research or the chief of terrestrial ecosystem research.

SER Director Bob Baker expressed belief that these changes "will focus existing financial and manpower resources, make our Region and parks more attractive for funding and cooperative programs with other agencies, and establish a more consistent research policy among the parks."

James R. Snyder (Big Cypress NP) and Alan Herndon and William B. Robertson, Jr. (both of Everglades NP) co-authored a chapter entitled "South Florida Rockland," published in *Ecosystems of Florida* (see Publications, p. 19 this issue). The chapter (pp. 230-277) describes the tropical hammocks and pine-

regional highlights

lands that occur on limestone in south Florida. Copies of the chapter are available from Snyder at Big Cypress National Preserve, S.R. Box 110, Ochopee, FL 33943.

* * *

Recent analysis of ambient surface water quality in Cape Hatteras NS indicates that the seashore is being affected by moderately degraded septic outflows from the neighboring town of Nags Head. Andrew Cole, NPS/CPSU at NC/State/U, has found high levels of fecal coliform bacteria in the canals and ditches draining Nags Head through the seashore. Since the water samples also contain low levels of optical brighteners, a man-made dye used in laundry detergents, Cole suspects the pollution may be coming from underground septic sources. This would suggest an extensive subsurface transport system in which the septic effluent moves through the groundwater. Nags Head officials are being kept informed of the study and have expressed interest in working with the park to solve the problem. The study, with recommendations, is scheduled for July 1991 completion.

* * *

Two graduate students working with the NPS/CPSU at U/GA have won awards for their research efforts.

Bart Johnson won first place in the 1990 American Society of Landscape Architects (ASLA) National Student Design competition in the research category for his "Rare Plant Habitat Protection" project on the Blue Ridge Parkway. Bambi Teague of the Blue Ridge Parkway and Susan Bratton of the U/GA CPSU assisted Bart in this project.

Jim Boone, formerly a seasonal ranger at Sequoia-Kings Canyon NP, received the Stoddard-Sutton-Burleigh award for his thesis and published work on the genetics of a Cumberland Island (GA) population of the cotton mouse, *Peromyscus gossypinus*. (See *Park Science*, Fall 1990, p. 7). The award is given annually by U/GA for outstanding achievement in wildlife conservation.

Western Region

The Sequoia and Kings Canyon NPs Second Century Conference was held in Giant Forest Oct. 5-7, 1990, in honor of the 100th anniversary of Sequoia NP and the 50th anniversary of Kings Canyon NP. Designed to address issues facing these parks in the coming century, the conference brought together people from conservation groups, concessionaires, special interest user groups, park management, and the general public. RD Stan Albright, Supt. Tom Ritter, and Conference Coordinator Bill Tweed welcomed the conferees, who then heard keynote addresses by Dale Crane (NPCA), Boyd Evison (AK RD and former SEKI superintendent), Jerry Franklin (USFS ecologist), and Norman Livermore (retired packer and conservationist).

Special workshops were held on Purpose of the Parks, Limits to Frontcountry Growth and Use, Backcountry Use, Adjoining Lands, and Regional and Global Issues. A proceedings, including the principal addresses and working group recommendations will be prepared.

* * *

David Parsons presented an invited paper at the UC/Davis Landscape Ecology Conference (Oct. 3-5) in Sacramento, CA. His topic was "Managing the Greater Sierran Ecosystem: The Landscape Dimension." This presentation, together with one given later in the month

at the Yosemite Centennial Symposium and Natural Areas Assn. annual meeting, addressed the growing importance and interest in a regional, interagency approach to science and management in the Sierra Nevada.

* * *

Five technical reports and one special report have been completed by CPSU at U/AZ. They are:

Baisan, Christopher H. Fire History of the Rincon Mountain Wilderness, Saguaro NM. Tech. Report #29.
Duncan, Douglas K. Small Mammal Inventory of Chiricahua NM, Cochise County, AZ. Tech. Report #30

Reichhardt, Karen. Autecology of Arizona Sycamore (*Platanus wrightii* Wats.), A Critically Important Species in South-Central Arizona. Tech. Report #33.

Despain, D.W. and J.C. Mosley. Fire History and Stand Structure of a Pinyon-Juniper Woodland at Walnut Canyon NM, AZ. Tech. Report #34.

Bennett, P.S., R.R. Johnson, and M.M. McCarthy. Assessment of Scientific Information and Activities at Organ Pipe Cactus National Monument Biosphere Reserve. Special Report #10.

Copies of these reports may be had by contacting the CPSU at Tucson, (602) 670-6885.

* * *

Mary Ann Madej, Geologist at Redwood National Park, and Dr. Thomas Lisle of the U.S. Forest Service presented an invited talk titled "Spatial variation in armoring in a channel with high sediment supply" at the Third International Workshop on Gravel Bed Rivers held in Florence, Italy September 23-28, 1990. The paper will be published by John Wiley and Sons in a book entitled "Gravel Bed Rivers." Mary Ann Madej received an award from the Horace M. Albright Employee Development Fund to attend this meeting.

Pacific Northwest

The Pacific Northwest National Park and Forest Association at 83 S. King St., Seattle, WA 98104, officially became the Northwest Interpretive Association as of Oct. 1, 1990.

News of the name change came from Executive Director Mary Ellen Rutter, who also announced that the association is selling (for \$10 each, plus \$2 mailing charges) 75th NPS Anniversary T-shirts sporting the diamond logo in green and blue on white, in sizes S, M, L, and XL.

* * *

Two lakes on opposite sides of the world – Crater Lake in Oregon and Lake Baikal in the Soviet Union – share one unusual similarity: they are the only known freshwater lakes in the world that may have hot springs on the bottom.

Grigory I. Galazy, a Lake Baikal scientist and director of the Baikal Ecological Museum, is one of two Soviet scientists who visited Oregon in October 1990 as part of an exchange program. "We're counting on the fact that between our lake and Crater Lake there will be some definite organized cooperation in the future," Galazy said after taking his first look at Crater Lake.

The visit came two months after a Soviet-American team found evidence of a hot vent field in Lake Baikal. The vent area, which lies about 1300 feet down at the lake's northeastern corner, supports a community of sponges, bacterial mats, worms, snails, and fish. The sponges are white and grow in circles. The spring area

is significantly warmer – as much as 24 degrees F warmer – than the water surrounding it.

Oregon State University oceanographers Jack Dymond and Robert Collier are completing a draft report for NPS of the 1990 summer research in Crater Lake, where the pair found the warmest temperatures ever detected in the lake – 66 degrees F – in a bacterial mat on the lake's floor. The reading was 28 degrees higher than the surrounding water temperature.

Removal of Dams Essential To Ecosystem Restoration

In the Fall 1989 issue of *Park Science*, John Aho and John Meyer reported on the effort by Olympic NP to restore anadromous fish into the upper Elwha River above two hydroelectric dams. While restoration of native salmon, char, and trout runs is the objective, the overriding goal is restoration of the ecosystem and natural processes, of which the fish are an integral component.

Olympic NP and several resource agencies (known collectively as the Joint Fish and Wildlife Agencies – JFWA) have been examining two alternatives for restoring these fish resources. The first alternative is provision of state-of-the-art fish passage facilities at the two dams. The second alternative is removal of both dams.

During 1990, the JFWA gathered information and assessed feasibility of restoring 10 endemic stocks of anadromous fish under each alternative. Information assessment showed that under the state-of-the-art alternative, only 4 or 5 of the original 10 stocks could be restored, and the restoration chances of these were only fair. With the dams' removals, chances are fair to good of restoring all stocks.

Olympic also examined potential effects on the ecosystem that would result from restoration under these 2 alternatives. Returning significant quantities of fish biomass was considered to be a critical factor in restoring natural processes. Biomass from fish carcasses, eggs, and juveniles, would be reduced by about 75 percent if the dams remain.

Because of the lower number of stocks that can be restored with the dams in place and the significantly lower biomass available to the ecosystem, Olympic NP has determined that only through removal of the dams can the park's restoration goals be met. USFWS has concluded that the dams should be removed. THE JFWAs are examining methods of removing the dams and stabilizing the sediments stored in their reservoirs. Much work remains before restoration can occur, but Olympic NP staff are encouraged over the possibility of restoring natural processes in this 175,000 acre watershed.

John Meyer
Olympic NP Fishery Biologist

Rocky Mountain

The results of a 2-year survey for threatened and endangered plants in Zion NP have been received. In order to determine what species might be threatened or endangered, all species seen were identified. A total of 161 plants was added to the list of those known from the park, including a new variety of *Lomatium* and a

Rocky Mountain (Continued)

new species of *Carix*, increasing the plant list for Zion from 738 to 899 species.

Some of the plants located during the survey were new State records. *Valeriana arizonica* was found on the West Rim trail. This species was collected by Walter P. Cotton in the park about 60 years ago and it had not been identified again until this survey. Over 20 species of endemics were discovered by the survey. Many isolated areas including the large free-standing mesa tops were not covered, and further research is needed to complete this work.

A recent meeting at Zion NP ended the first phase of the development of a step-down plan to guide research and resource management over the next 10 to 15 years. Charles Van Riper III, from the Northern Arizona University CPSU, provided the guidance for developing the plan's components. Professors from several universities and colleges participated in working out the plan's framework and assisted in determining work priorities. Baseline inventories for each resource discipline also have been developed. Further work will create a similar plan for cultural resources.

In August, a single bison (*Bison bison*) was translocated from Wind Cave NP to Grand Teton NP in an effort to maintain genetic variability in Grand Teton's relatively small, genetically isolated bison herd. The introduction was called for in the Annual Management Program for the Jackson Herd, which is developed every year by agencies sharing jurisdiction for managing the herd, including the NPS, USFS, USFWS, and Wyoming Game and Fish Department. The Jackson herd, now numbering approximately 120 animals, summers in Grand Teton NP and winters on the National Elk Refuge in Jackson, WY. Coordinated by Grand Teton biologist Steve Cain and Wind Cave chief ranger Steve Bone, the translocation was the first involving the Jackson herd since 1963 when 10 bison were introduced from Theodore Roosevelt NM.

The Wind Cave bison herd was chosen as the donor population because it has the highest level of heterozygosity known among several western herds that have been tested. The yearling female bison, selected because a young female is most likely to make a significant genetic contribution, was field-immobilized, corralled and observed for a few days by Wind Cave personnel, and then transported via horse trailer by Grand Teton biologists. Even though released in sight of the Jackson herd, the introduced animal remained solitary for about 3 weeks before finally joining the other animals. She was fitted with ear tags and a radio collar, so that her movements and reproductive status can be monitored on a regular basis. Park biologists anticipate that she will breed during the 1991 season. The success of this major effort can to a large degree be attributed to the outstanding level of inter-park cooperation brought about by both Grand Teton and Wind Cave personnel.

A deer drive was conducted at Devils Tower NM on Oct. 20, 1990 to get a census count of the population within the park. The drive was organized by co-principal investigator Evelyn Merrill and research technician Greg McDaniel and included U/WY students, Moorcroft Search and Rescue and park personnel. The drive people were split into two groups to cover the 1346 acre park which is bordered by a game-proof fence on its north and west boundary. One group of 25

Mexican Spotted Owls Shyer Than Their Northern Cousins

The controversy surrounding the habitat needs and population status of the northern spotted owl (*Strix occidentalis caurina*) has led inevitably to concern about the Mexican subspecies (*Strix occidentalis lucida*). Therefore, a study of abundance and distribution of Mexican spotted owls in Zion NP was made in 1989 and 1990. During the 2-year study, vocal imitations were used to elicit responses from the owls. A 45.7cm diameter plastic parabolic dish and microphone was used in listening for the owls and to monitor calling between pairs. Remote and inaccessible areas also were surveyed by using the parabolic microphone. In some instances, the owls would not respond to vocal imitations, so the parabolic microphone was used to listen for vocalization between pairs.

The monitoring sessions usually lasted from 8 p.m. to 5 a.m. Vocal imitations were done for 10 minutes each hour; the remaining 50 minutes were used to listen for responses. The survey efforts turned up 6 pairs and 4 individuals in 10 different locations. Some banding of both adults and juveniles was accomplished.

Spotted owls are widely distributed in Zion and their locations appear to follow a patchily distributed habitat. Owls were found inhabiting steep-walled canyons and deep gorges. Detecting Mexican spotted owl responses in this country appears to be more difficult as compared to the northern subspecies in the Pacific Northwest. This makes the parabolic dish necessary for locating the owls throughout the rugged terrain of Zion NP.

people lined the north boundary and walked together to the south boundary and the other stationary group lined the east and south boundary. Deer were counted that passed through the walking line and the line on the boundaries. A total of 180 deer were counted - 117 whitetail and 63 mule deer. From comments after the census it is believed 20 percent of the deer on the Monument were missed. This drive is part of a three year study of deer in the park which includes monitoring of deer daily and seasonal movements from the 16 radio-collared doe deer and extensive habitat analysis of the area.

Dr. Paul Buchheim recently completed the first of three field seasons in the Fossil Lake Basin, of which Fossil Butte NM is a part. He will collect similar time horizon samples at 70 locations over a three-year period. Analysis of these samples will give important insight into lake depth, salinity, temperature, faunal elements and climate changes through time.

The results of this study will be a series of 10 "time slice" maps, which will portray Fossil Lake throughout its history. An understanding of these aspects of Fossil Lake will also allow us to relate the Eocene climate changes to changes taking place in present day lakes and oceans. Similar research is being conducted at the Salton Sea in California. Comparisons can be made between the modern and ancient lake systems.

In October 1990, staff at Bryce Canyon NP conducted the first in a series of prescribed burns planned for 2000 acres in the northwest part of the park. Fire suppression and past livestock grazing altered fire frequency in the park, thereby changing fuel loads, vegetation structure and species composition. Park staff and university scientists have been collecting baseline data needed to plan prescribed burns since 1980. Plant community type, habitat type, and fuel load maps have been prepared, and fire history has been studied. Monitoring programs for vegetation, fuel loads, birds and small mammals have been established, and fire effects on these resources will be evaluated. Fires are planned for remaining burn blocks during each spring and fall through 1992.

Region is entering its third year of a peregrine falcon recovery program. Parks with peregrine populations will by the end of the year have completed intensive and complete surveys as well as the development of a long term monitoring plan to selectively sample portions of park populations.

The Region is prepared to initiate in FY91 an unprecedented effort in surveying Colorado Plateau Parks for Quaternary resources. Although continued discoveries of extinct ice-age mammals such as mastodons and mammoths appear irregularly, no systematic evaluation has yet been made.

Grand Teton and Yellowstone parks hosted a service-wide level tour for participants interested in ongoing research and application of native plant materials to disturbed areas within parks. Application of research findings and use of the plant materials program and expertise of the Soil Conservation Service may have significant input towards future revegetation attempts in parks.

Guide to Florida's Natural Resources

On Nov. 15, 1990, the University Presses of Florida published the first comprehensive guide to Florida's natural resources in 60 years. The book (728pp) is titled *Ecosystems of Florida*, edited by Ronald L. Myers and John J. Ewel, with a foreword by Marjorie Harris Carr.

In straightforward text supplemented by charts, maps, and illustrations, *Ecosystems of Florida* provides what Patrick Smith, author of *A Land Remembered*, calls "a treasure chest of fascinating information about Florida - both past and present ... and an intimate understanding of why Florida is what it is."

At a time when population growth and development are straining the state's natural resources as never before and involving the National Park Service in Herculean efforts to save Everglades NP, this book provides a scientific benchmark for each of the peninsular state's complex, fragile environments ... an assessment of the character, relationships, and importance of Florida's ecosystems, the organisms that inhabit them, the forces that maintain them, and the agents that threaten them.

Ecosystems of Florida is available in cloth (\$75) and paper (\$29.95) from University Presses of Florida at Gainesville, 15 NW 15th St., Gainesville, FL 32607; (904) 392-1351.

publications

The following new publications produced by the NPS publications program, are available from NPS Publications Coordinator Donna O'Leary, NPS Natural Resource Publications Office, c/o Air Quality Division (AIR)m PO Box 25287, Denver, CO 80225-0287. (303) 969-2156.

North Pacific Salmonid Enhancement Programs and Genetic Resources: Issues and Concerns, by Michael D. Kelly, Patricia O. McMillan, and William J. Wilson. 232pp.

1989 Inventory of Research Activities in the National Parks (second annual science report), 386pp.

Protecting Biological Diversity in the National Parks: Workshop Recommendations, edited by Dominic Dottavio, Peter F. Brussard, and John D. McCone. 79pp.

Examples of Resource Inventory and Monitoring in National Parks of California, edited by Charles van Riper III, Thomas J. Stohlgren, Stephen D. Veirs, Jr., and Silvia Castillo Hillyer. 268pp.

Role of Biological Control As a Management Tool in National Parks and Other Natural Areas, by Donald Gardner. 41pp.

Annual Report of National Park Marine Debris Monitoring Program: 1989 Marine Debris Survey, by C. Andrew Cole, John P. Kumer, David A. Manski, and Daniel V. Richards. 31pp.

Highlights of Natural Resources Management 1989. 39pp.

Shenandoah National Park Long-term Ecological Monitoring System User Manuals. Approx. 300pp, consisting of 5 Sections: Overview, Forest Component User Manual, Aquatic Component User Manual; Gypsy Moth Component User Manual, and Database Management System Component User Manual; the work of eight editors from Shenandoah NP and Virginia Polytechnic Institute and State University.

An Index Bibliography of Wildlife Research in the U.S. National Parks, compiled by R. Gerald Wright. 134pp.

Some of these books either have been or will be given further review in these pages.

Isle Royale Book Wins Award

Moods, Magic and Mystique, the Isle Royale Natural History Association's color publication about Isle Royale NP, has won first place, as well as the prestigious Directors Award in the NPS Cooperating Associations publication competition. Approximately 200 new publications were entered in the nationwide competition.

The judges included *National Geographic* art director and the National Gallery of Art's editor-in-chief. Their comments: "Covers and title pages are knock-outs. A beauty throughout, gorgeous photography, beautiful book, beautifully produced, profoundly poetic ... mood-creating photos match the evocative text."

The book may be had from Isle Royale NP headquarters, Houghton, MI 49931. Bruce Weber, park naturalist and Association Coordinator, can be reached at (906) 482-0986.

George Wright Society Sixth Conference

The George Wright Society's Sixth Conference on Research and Resource Management in the National Parks and Equivalent Reserves, held in El Paso, Texas, November 12-17, 1990, was a highly successful communion of diverse people concerned with the future of parks. The nearly 400 participants from federal science, resource management, park management, and interpretation, academia, and other sectors gave and heard papers ranging from the spiritual, political, and regional dimensions of park resource management to hazardous trees and threats to the winged mapleleaf freshwater mussel.

The sessions were organized by types of threats to parks, and the first product of the conference was a vote on the five most critical threats – as a guide in identifying issues for the George Wright Society to focus on in the 1990s. The top five were global climate change, animal population management, monitoring of park resources, communication of threats to parks, and external influences, not necessarily in that order. The Society has been enabled to put more effort into such issues by the generous gift of \$277,000 from a daughter of George Wright, Mrs. Sherry Wright

Brichetto, who was honored at the conference.

Several speakers applauded the sizeable representation of top NPS management, which included two former Directors, three Associate Directors, six Regional Directors, four Deputy Regional Directors, and a number of superintendents. Director Ridenour, unfortunately, was called away at the last minute by urgent business in Washington. Also absent were large numbers of people from the cultural resource side, a deficiency the George Wright Society hopes will be remedied at future conferences.

Co-chairmen Tom Gavin (program organization and overall coordination) and Frank Smith (local arrangements) received thunderous applause for putting together a well-organized, enjoyable conference that informed and reenergized all present to pursue the mission of parks in our complex world.

The conference papers will not be published in a Proceedings, but some will appear in the *George Wright Forum*. Other papers may be obtained from the authors.

Napier Shelton
NPS Washington Office

meetings of interest

1991

March 4-8, "FROM DESIGN THROUGH CONSTRUCTION: THE CONTINUUM OF EXCELLENCE," workshop sponsored by the Department of the Interior and the Denver Service Center, at Colorado Springs. Four areas to be covered are Design and Construction Theory and Practice, Project Management, Contracts, and Communications and Negotiations.

March 22-27, 56TH NORTH AMERICAN WILDLIFE AND NATURAL RESOURCES CONFERENCE, at the Edmonton Convention Center in Edmonton, Canada. Theme, "Sustaining Conservation: An International Challenge." Documentation required for foreign travel must be in the AD/NR's office by end of January.

May 14-19, INTERNATIONAL CONFERENCE ON SCIENCE AND THE MANAGEMENT OF PROTECTED AREAS, at Acadia University, Wolfville, N.S. Canada. To serve as a forum for examining current perspectives on the role of science in managing protected areas and the role of protected areas in the conduct, support and promotion of scientific research, and as a lead-up to the IUCN World Parks Conference, 1992. Contact Neil Munro, Director, Policy Planning & Research, Canadian Parks Service, Atlantic Region, Environment Canada, Historic Properties, Halifax, Nova Scotia, Canada, B3J1S9.

May 19-23, THIRD ANNUAL SOCIETY FOR ECOLOGICAL RESTORATION CONFERENCE, in Orlando, FL. Contact SER, 1207 Seminole Highway, Madison, WI 53711; (608) 262-9547.

May 29-31, 12TH ANNUAL MEETING OF THE SOCIETY OF WETLAND SCIENTISTS, at Ann Arbor, MI, covering wetlands research and management from many different disciplinary approaches. Contact: Douglas A. Wilcox, USFWS, National Fisheries Research Center-Great Lakes, 1451 Green Rd., Ann Arbor, MI 48105; 303/994-3331.

Oct. 16-20, 45TH NATIONAL PRESERVATION CONFERENCE, "Historic Preservation for the Next 25 Years," at the St. Francis Hotel, San Francisco; sponsored by the National Trust for Historic Preservation, the NPS, and the Advisory Council on Historic Preservation. Contact, Vice President, Programs Service and Information, National Trust for Historic Preservation, 1785 Massachusetts Ave., NW, Washington, DC 20036.

October (no date given in initial announcement), SOCIAL ASPECTS AND RECREATION RESEARCH SYMPOSIUM, Theme, "Wildland/Urban Interface," at Lake Tahoe, interfacing resource managers and scientists in small group discussions of research findings. Sponsored by USFS, BLM, Society of American Foresters and others. For information write Debbie Chavez, SARR Symposium Coordinator, USDA Forest Service, 4955 Canyon Crest Drive, Riverside, CA 92507.

Nov. 4-8, THIRD GLOBAL CONGRESS OF HERITAGE INTERPRETATION INTERNATIONAL, in Honolulu, to explore how effective interpretation can help protect natural and cultural heritage while providing meaningful and memorable experiences for residents and visitors. Contact: Gabriel Cherem, EMU Geography & Biology, Ypsilanti, MI 48197; (313) 487-0218, or Ray Tabata, UH Sea Grant, (808) 948-3191.

Rare Plant Monitoring and Management at Point Reyes

By Gary M. Fellers and Virginia Norris

Rare plants are not assured of survival simply by growing on lands protected by public parks. Their preservation also demands careful, long-term monitoring and, from time to time, well-designed intervention. Most parks have limited resources and may find it difficult to provide sufficient protection for their rare plants. Point Reyes National Seashore (NS) has developed a cooperative program with the California Native Plant Society (CNPS) to monitor and manage rare plants.

The Seashore, located 40 miles north of San Francisco, includes sandy and rocky beaches, coastal prairie, Douglas fir and Bishop pine forests, chaparral, and wilderness lakes. About one-third of the Seashore is designated a pastoral zone with both dairy and beef cattle ranches. In large part due to the wide diversity of habitats, strongly maritime climate, and southern geological origin, Point Reyes has a remarkably diverse flora with 828 species and an additional 35 varieties and subspecies. About 16 percent of the entire California flora is represented in an area of only 114 square miles.

Not surprisingly, this diverse flora includes a significant number of rare plants. Forty-two of the species listed in the 1988 edition of the CNPS's inventory of the state's rare and endangered plants have been reported from Point Reyes or are likely to occur within the Seashore. Two of these are presumed to be extinct, four are presumed to have been extirpated from the Seashore, 30 have been confirmed since 1983, and another six are objects of current searches. Four of the 42 species are listed by the State and 33 are candidates for Federal listing.

In the early 1980s, the Seashore had very little information on most of the rare plants, and was concerned that they might inadvertently be threatened by grazing, or that the Seashore's fire management program might have a negative impact on them. From 1983 to 1984, the Seashore conducted a systematic search for rare plants, which documented the occurrence of 21 species. (Clark and Fellers, 1986).

The final report recommended some immediate management actions and outlined an ambitious monitoring program that would allow the Seashore to track rare plant populations and assure their continued survival. The rare plants were to be resurveyed at intervals ranging from one to four years, depending on their rarity and possible endangerment.

The Seashore promptly began some of the specified management, but resources were not available to monitor all the rare plants. Meanwhile, the list of those expected to occur at Point Reyes had increased, due to new information on plant distributions and additions to the CNPS rare plant inventory.

CNPS Volunteers

In 1986, the CNPS contacted the Seashore to volunteer its assistance in monitoring rare plants. A priority list of plants was agreed upon and the Seashore provided copies of the rare plant report, topographic maps, photographs of the plants, and occasional assistance in the field. Weekly field trips were scheduled throughout the spring and were announced in the CNPS newsletter. By the end of that season, 13 CNPS botanists had visited 16 historic sites and had discovered two new populations of rare plants.

The first year demonstrated the success of the cooperative program. The volunteers had shown sustained interest in the project and had been able to relocate



Monardella undulata

and survey known populations of rare plants as well as find new populations. The CNPS leaders contributed a substantial amount of time, not only in organizing and leading the field trips, but also in preparing field survey reports and maps for each visit to every rare plant population. These field forms were filed at the Seashore and a copy sent to state and county CNPS offices as well as to the California Natural Diversity Data Base, which is maintained by the State Fish and Game department.

The cooperative monitoring program has grown considerably since that first year. During the 1989 field season, 34 botanists participated in 27 field days of monitoring. As CNPS botanists became more familiar with Seashore terrain and the habitat characteristics of each new species, they were able to locate many more new populations – 21 in 1988 and 22 in 1989.

The Seashore has continued to participate in the rare plant monitoring on a limited basis. Initially, the list

of plants and populations to survey was developed jointly, but planning now is done primarily by the CNPS botanists. Seasonal park botanists have joined a number of field trips and have worked in more detail on selected plants (see below). The Research Biologist has assisted with finding some of the more difficult historic localities and with identification of some of the grasses.

During the first five years of the cooperative monitoring program, 94 people have surveyed for rare plants at Point Reyes. Some came only occasionally, but seven people have averaged more than 50 days each. They have located 29 species of rare plants and have made significant contributions to the knowledge and management of Seashore flora.

Management of Rare Plants

With CNPS volunteers conducting most of the monitoring, the Seashore has been able to focus its resources on managing the most vulnerable rare plants. The species identified as most in need of immediate protection in 1984 was the Sonoma alopecurus (*Alopecurus aequalis* var. *sonomensis*). In 1985, the Seashore constructed an enclosure around the only known population, to keep cattle out. Over the next several years, the marsh vegetation within the enclosure flourished, but the population of alopecurus declined from 35 plants to one. Clearly the fence was not helping and may even have contributed to the decline by allowing other species of plants to thrive and out-compete the alopecurus. Hence the enclosure was opened in June 1990.

Fortunately the Seashore also had started a greenhouse propagation program using seeds collected in 1986. Alopecurus proved to be easy to raise. The greenhouse provided over 400 seedlings, which were plants in three areas. The outcome of two introductions still is uncertain, but the third has done well, with 62 plants present in 1988 and 85 in 1989. All populations will be carefully monitored during 1991.

An important lesson to be learned from the alopecurus experience is that rare plants cannot

Concluded on page 21



Coastal dune habitat supports several rare plants, including beach layia and curly-leafed monardella. Here, Myrtles Silverspot is shown on its North Beach habitat.



Volunteers search for Sonoma spineflowers at Point Reyes National Seashore.

always be preserved merely by protecting them from grazing or trampling. Some species are adapted to disturbance or may benefit from the control of competing vegetation. Hence it is important to understand the ecological interactions within the plant community before a full recovery effort is implemented. When immediate action seems warranted because of an imminent threat, it must be done carefully, with constant monitoring of results.

The Seashore is applying this experience to its management of the Sonoma spineflower (*Chorizanthe valida*), a species being proposed for Federal listing. The plant currently is recognized as the most endangered at Point Reyes. While this species has been reported from several other coastal populations, all but the one at Point Reyes now are disputed or believed to have been extirpated. The single Seashore population appears to be healthy, but it does occur in an area that is grazed and the question of grazing impact has again been raised.

This time the Seashore has taken a more experimental approach by protecting a small number of plants with test exclosures while leaving most of the population alone. Thus far it appears that the spine-

flower does better with grazing (Davis and Sherman, 1990). Further monitoring and competition experiments are planned.

Another plant of current interest is the Point Reyes lupine (*Lupinus tidestromii* var. *layneae*). Because of the loss of coastal dune habitat, the Point Reyes lupine is being proposed for Federal listing as a threatened species. At Point Reyes, the lupine is known from one extensive and four small populations. The larger site has been trampled by cattle with an obviously detrimental effect on the lupine and other dune species. The Seashore has now fenced the dunes to protect both the dune vegetation and nesting Snowy Plovers.

At least one, and possibly more, of the other lupine sites are threatened by non-native iceplant (*Carpobrotus edulis*). The CNPS botanists have documented the increasing threat from iceplant to the lupine as well as to two other rare dune plants, the beach layia (*Layia carnosa*) and the curly-leafed monardella (*Monardella undulata* var. *undulata*). While the iceplant problem seems almost overwhelming in some areas, the Seashore has begun removal experiments and currently is working on one small dune restoration project. Iceplant at that site was removed by bulldozer and

native dune species are being tested for their ability to stabilize windblown sand along roads.

Overall, rare plants at Point Reyes NS are doing well. The cooperative program between the Seashore and the CNPS has allowed the Seashore to track the status of rare plants while conducting essential management of the most vulnerable species. The Seashore now regularly consults the CNPS botanists, or the extensive rare plant files, about proposed projects that might affect rare plants. As a result, the chance of accidental damage to rare plants has been greatly reduced.

The experience of the past four years clearly demonstrates that this close partnership has produced a valuable program for protecting an important segment of California's rare flora.

Fellers is the research biologist at Point Reyes NS; Norris is a member of the Marin Chapter of the CNPS and current leader of the CNPS volunteers.

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Rabbits Invade Haleakala NP

Even though oceanic islands are known to be highly vulnerable to biological invasions, conventional wisdom has held that escape or release of domestic rabbits (*Oryctolagus cuniculus*) poses no significant threat to native Hawaiian ecosystems or local agriculture. This assumption is now obsolete.

Haleakala NP initiated rabbit removal and monitoring in July 1990, following discovery of a reproducing population covering about 25 ha in high elevation (2070-2140 m) native shrubland. Because of the perceived threat of an established rabbit population, rabbit eradication was placed as the #1 park priority.

Through a complex series of inquiries, it has been learned from the person who released the apparently colonizing animals that six rabbits were released in October of 1989. This date coincides with the month of the first record of a rabbit in Haleakala NP – an injured animal which appeared to have been attacked by an Hawaiian short-eared owl. In spite of possible predation by owls, mongooses, and feral cats (7 mongooses and 6 cats trapped within 2 km during January-October 1990) and winter weather (1186 mm or 47 inches of rain fell in the area during November-March), the cage-reared animals managed to persist and reproduce.

As of Oct. 24, 1990, 79 rabbits had been removed, through snaring (45), shooting (24), and trapping (10). Fencing has been used to separate control efforts from an active campground. Monitoring of transects (assessment of rabbit pellet presence/absence, age, and abundance), suggests that areal expansion of the population since its discovery has been minimal and that control is significantly reducing the population. Simple calculations suggest the conclusion that without prompt eradication efforts, rabbits would have numbered in the millions within five years of their introduction.

Meanwhile, the park is faced with the awesome responsibility of attaining complete eradication.

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Chorizanthe valida



Layia carnosa

Special Initiative Funding For Servicewide Projects Now Into Second Year

In November 1989, a call went out to NPS Regional Directors from the Associate Director for Natural Resources (AD/NR), for "pre-proposals for substantive technical investigation of two critical issues of Servicewide importance:

- The management of animal populations
- The role of diseases and parasites in natural ecosystems."

The first of these issues had been identified by NPS Regional Chief Scientists as a high priority; the second is emerging as a significant national problem as parks become more and more surrounded by intensive human developments and activities.

A number of excellent pre-proposals emerged, many of them involving cross-Regional staff work in a Servicewide partnership. Seven were chosen for funding in FY 1990; one was in the area of synthesis of large mammal activities, three involved modeling animal population dynamics, one concerned restoration of native animals and removal of exotic animals from park areas, and two dealt with the role of diseases and parasites.

As AD/NR Eugene Hester noted in his October 11, 1990 memorandum to the field, the FY90 effort was "a well-conceived, though modest, program," whose success was due in part to the early involvement of the Regions. Dr. Hester had framed his 1989 Call for Pre-proposals as a response to comments of the Regional Chief Scientists regarding increasing the involvement of Service personnel in carrying out the purposes of the Natural Resources Special Initiatives program. "I welcome this involvement," he said at the time.

In an October 11, 1990 follow-up, Dr. Hester has informed the Regional Directors that he would like to continue the program in FY 1991. He notes that the FY90 program "complemented our overall Natural Resource Preservation Program (NRPP) project list and related closely to the major Servicewide issues we have identified through the Natural Resources Assessment and Action Program and other mechanisms," and solicits pre-proposals for specific projects in the following categories:

1. Effects of Urbanization and/or Boundary Development on Park Environments;
2. Management of Animal Populations;
3. Managing Human-Natural Resource Conflicts and Issues; and
4. Other proposals that address Servicewide natural resource policy issues, especially those that are interdisciplinary and multi-regional in scope.

Pre-proposals were due to the AD/NR by December 14, 1990. January 11, 1991 is the date set for issuance of the invitation for proposals. Proposal deadline is February 22; award decisions are slated for March 15, and funds will be transferred on March 29, 1991.

Park Science will be reporting on the seven projects funded in FY90 as results become known.

In the Pacific Northwest Region, the three funded projects are (1) a synthesis of activities and issues related to wildlife management in the National Parks; (2) development of a conceptual model to provide guidance for the management and regulation of animal species in the National Parks, and (3) animal disease issues in the National Park System.

The other four projects funded in FY90 are:

Midwest Region, population management of white-

tailed deer in relation to spatial attributes of Midwestern NP areas; Southwest Region, landscape structure and its impact on interpretation of desert mule deer population; North Atlantic Region, arthropod-borne diseases in and near national parks, national seashores,

national lakeshores, and national rivers in the continental US; and in the Western Region, restoration of native animals and removal of exotic animals in NP areas.

mab notes

Televisio de Catalunya in Barcelona, Spain is planning a 13-part series called **Biosphere**, to be filmed in biosphere reserves (BRs) around the world. Each 1-hour program will focus on a different biome, using BRs as representative areas of that biome. Altogether BRs from about 20 countries will be featured. The programs will describe each biome's natural condition, its use by people, and its environmental problems, as well as research and education in the representative BRs. Bill Gregg, NPS MAB Coordinator, calls the project "the biggest boost yet for the MAB program." Olympic NP, the Southern Appalachians, and the Noatak National Preserve, representing, respectively, temperate rainforests, temperate broadleaf forests, and tundra communities, are being considered as proposed filming sites. The filming will take place in 1991 and early 1992, for showing in Spain in late 1992.

This ambitious project, expected to cost \$2.2 million for the Spanish version alone, does not end there. Sponsorship is being sought for translation and use in many other countries, and UNESCO-MAB has agreed to assist with worldwide distribution. Coffee-table book versions are planned. Also being considered are interactive videos for use in visitor centers and other such places, and widescreen (I-MAX) film versions. The director of operations of Televisio de Catalunya came through the NPS Washington office in June 1990. Bill Gregg assisted her with planning and other meetings in Washington, which included the Smithsonian Institution, the Discovery TV channel, and public television.

Biosphere was conceived by Ramon Folch, Secretary of the Spanish MAB committee and producer at Televisio de Catalunya. This project follows a highly successful series by this TV station on the Mediterranean basin, showing environments and their human use.

Meeting at Hog Island, VA, Oct. 10-12, 1990, the newly constituted **MAB Biosphere Reserve Committee** began development of an action plan for U.S. BRs. Discussion focused on the mission, statement, goals, and a number of proposed action items.

The October 1990 issue of the **U.S. MAB Bulletin** announced the **U.S. MAB grants for FY 1990**. Among these is the first funded project to be directorate-proposed and carried out by its members to pursue research on the major program area of the directorate. This \$300,000 grant will support the first 2 years of a comparative study by the Temperate Ecosystems Directorate of the effects of surrounding land ownership patterns on the biological diversity and socioeconomic viability of managed and protected land in the Olympic Peninsula and the Southern Appalachians.

One of the principal hypotheses to be tested is that the large blocks of managed privately and publicly owned forest land on the Olympic Peninsula have resulted in landscapes with less ecological connectivity, habitat abundance, and resource stability than the intermixed, comparatively small blocks of public and private land in the Southern Appalachian region.

Another grant of special interest to NPS readers is one for a study of the use of marine harvest refugia as fishery management tools in the Channel Islands NP and BR area (Gary Davis, principal investigator).

The **Mammoth Cave Area Biosphere Reserve** was dedicated Sept. 26, 1990. This event should further strengthen mutual ties between the national park and surrounding lands, the quality of whose surface and subterranean water is so critical for park health. The ceremony was held in conjunction with the Eastern/Southern Regional Heritage Conference of The Nature Conservancy, with Judge David Martin representing the Barren River Area Development district - co-sponsor of the BR nomination, Bob Baker, NPS Southeast Regional Director, and others involved in the BR program. The BR includes Mammoth Cave NP as the core area and the park's 82,000-acre groundwater recharge basin as the transition zone.

A **plenary session on biosphere reserves** was held Oct. 18, 1990, at the symposium on Natural Areas and Yosemite: Prospects for the Future. Bill Gregg, who gave the introductory presentation, reports that a diverse audience of some 250 people showed considerable interest in the BR program. Discussions included the emerging leadership role of California (which now has 8 BRs) in the BR program, and the possibility of establishing a Sierran BR, where a good dialogue already exists between the major public land managers - the NPS and the USFS.

The Government Printing Office (GPO) has made a modest concession on the price of the international **brochure on biosphere reserves**. The price per 100 copies now is \$225. Single copies still cost \$3. Called **Biosphere Reserves**, the brochure may be obtained from: GPO Bookstore, 710 North Capitol St., Washington, DC 20401; (202) 783-3238. New stock number: 044-000-02277. Small numbers of copies of the first edition, which differs only in the omission of about a dozen BRs from the map and list, and a different numbering system for the BR list, can be obtained free from David Figlio, Wildlife and Vegetation Division, NPS, PO Box 37127, Washington, DC 20013-7127; (202) 343-8135.

Napier Shelton
NPS Washington Office



Should Recreational Boating on Upper Delaware Be Limited? What We Have Learned

By David W. Lime and John F. Karish

Should a carrying capacity (or some form of recreation use limitation) be place on recreational boating on the Upper Delaware Scenic and Recreational River?

The answer **NO** is the conclusion from research conducted on the river since the late 1970s – especially research initiated since 1984.

As recreational use of America's outdoor resources grew rapidly during the 1950s and 1960s, planners and managers struggled to find answers to questions about "how much use is too much" and "How can overuse be controlled." Conventional wisdom called for action to manage the numbers of visitors, limit use during certain times or at specified locations, or increased capacity of park lands or facilities to accommodate more people.

In spite of the dubious definitions of carrying capacity and the frequent cautions and limitations presented for its application, many managers tacitly assumed

that if we could just come up with the maximum number of people to let use an area at any one time, their problems would be solved! *the move was on to find a magic number that would answer the troublesome questions: How much use is too much?

Management Objectives

Actually, recreational carrying capacity is a management concept – a way of thinking about recreational use problems and how to manage a particular resource. The basic thrust of such a framework must be grounded in the understanding that appropriate use determinations can only be applied in light of specific management objectives. Once objectives are established, indicators and standards can be identified and compared with on-the-ground conditions.

Despite many failures to establish recreational carrying capacities, the concept does have merit when one recognizes the complexity associated with establishing such capacities, and then begins to look at such capacities within the framework of specific, measurable, and attainable management objectives. Identifi-

cation of the types of conditions desired for an area can provide the basis for planning and management that will lead in the desired direction.

Research on the Upper Delaware

Recognizing the fundamental importance of management objectives, the emphasis of the Upper Delaware research program was switched very early away from the term "carrying capacity." Instead, it focused on information gathering, to aid resource managers and citizen advisory groups in setting proper management objectives and determining what an appropriate river recreation use should be on this particular river (Lime et al. 1985). Although limiting use might become an acceptable and needed management action, the importance of managing numbers of visitors as a primary product of the research was de-emphasized.

The cooperative research effort was built upon existing information and intensive discussion about how to define appropriate use on the Upper Delaware. Research was to deal with those persons and groups involved in influencing management directions for the river – the managers, the users, the commercial sector, and inhabitants of the region, including interest groups and riparian landowners.

Thirteen separate studies were conducted in the past 6 years, involving the Park Service, the Forest Service, and university scientists nationwide. Research was grouped into 4 major subject components: (1) The environment and impacts resulting from recreation use; (2) The nature of the users and their recreation experiences; (3) The social and economic aspects of the region impacted by recreational river use, and (4) The management system involved in overseeing and protecting the resource.

Boating Limitation – Is There a Need?

The consensus from the research is that the levels of boating and recreational conflict, as well as other problems associated with visitor use on the Upper Delaware, are not severe enough or of a nature to warrant use limit policies now.

In general, factors other than number of visitors, per se, are more useful in defining appropriate and acceptable recreational use on the river. Table 1 summarizes these findings and shows there was greater concern about many other issues such as litter, disposal of human waste, trespass on private land, overconsumption of alcohol, lack of or inadequate facilities, trip planning and interpretive information for visitors, and within-group conflicts.

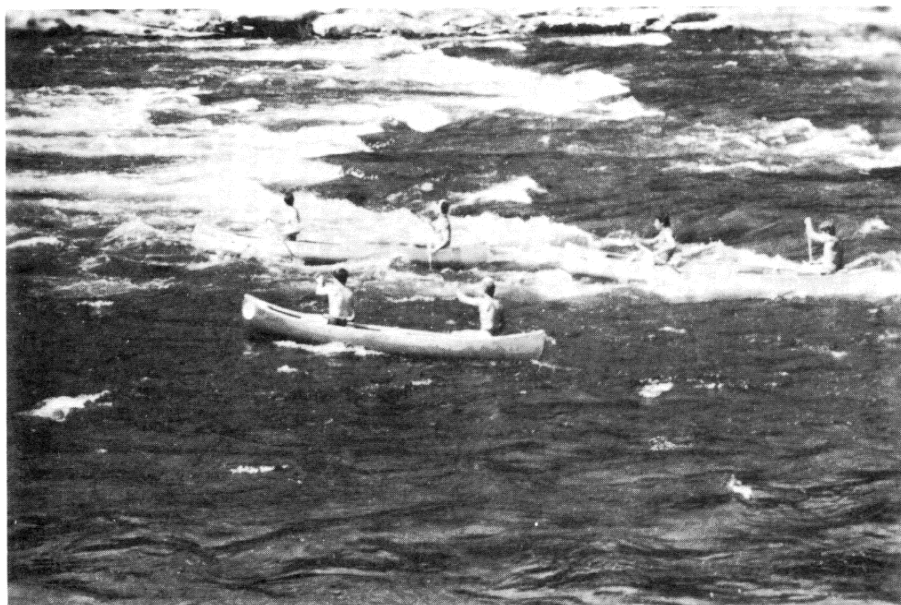
Few, if any, of these problems can be solved simply by limiting numbers of visitors. For example, reducing numbers of visitors alone would not solve the concern for excessive consumption of alcoholic beverages by river floaters. Visitor education, banning alcohol on the river, or increasing law enforcement might be a more direct and effective solution and actually might lead to increased visitation and fewer conflicts.

Reducing use also would not remedy most visitor-induced impacts to river campsites and other stopping places. Marion and Cole (1987) and Marion (1988), in addressing issues of ecological impact on recreation sites, found that trespass on private land in the river corridor was a widespread problem with resulting impacts. They showed that the amount of visitor use is not a good predictor of bio-physical impact on sites, because even limited use causes significant site

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Table 1. Studies of Appropriate River Recreation Use, Upper Delaware Scenic and Recreational River: Summary of Selected Conclusions Regarding the Limitation of Recreational Boating on the River

Topic/Issue Studied	Use Limits Recommended?	Selected Major Issues Noted in Studies
ECOLOGICAL STUDIES		
Site impacts at campsites & stops	No	<ul style="list-style-type: none"> Litter, human waste, soil & vegetation damage Many impacted sites on river Impact to individual sites often covers a large area
Wildlife impacts	No	<ul style="list-style-type: none"> Potential disturbance of wildlife by visitors Potential overfishing at some locations
RECREATION VISITOR STUDIES		
Boaters & floaters	No	<ul style="list-style-type: none"> Diverse but relatively minor problems – many beyond management control Alcohol consumption Lack of information about available routes, facilities Lack of facilities (toilets, drinking water, phones) Only a few visitors felt crowded Conflict within social groups of visitors
Tourism in general	No	<ul style="list-style-type: none"> Boater safety Lack of toilets, litter receptacles Lack of information about river access & facilities
SOCIO-ECONOMIC STUDIES		
Landowners	No	<ul style="list-style-type: none"> Trespass by visitors on private land (potential property damage) Protecting owners' privacy Litter Future regulations on uses of land in river corridor
Outfitters	No	<ul style="list-style-type: none"> Low water levels Water pollution Lack of clear jurisdiction Alcohol consumption Lack of facilities (toilets, drinking water, phones) Need for information & education of visitors River safety
River communities	No	<ul style="list-style-type: none"> Trespass by visitors on private property Lack of education & information for visitors Lack of facilities (rest stops, drinking water, toilets)
MANAGERIAL STUDIES		
Legislative intent	No	<ul style="list-style-type: none"> Legal to limit use; directives not explicit
NOTE: The conclusions presented in the table include research conducted as part of the NPS cooperative studies as well as other research on the Upper Delaware in the past 10 years related to the topic.		



No limit to the fun for Upper Delaware river recreationists.

Continued from page 23

damage. Educational efforts to improve visitors' knowledge and skills of minimum impact techniques seemingly would have a more positive influence on site impacts.

Among others, Knopf, Graefe, and Schreyer (1988) studied river visitors to determine the character of desired recreation experiences. Most visitors were well satisfied with their outing, and few reported that there were too many people on the river. Rather, many of the reasons visitors gave as detractors to their experiences dealt such relatively minor topics as weather and lack of toilet and drinking water facilities between access points.

Studies by Carroll, Twight, and McCabe (1987) report the history of federal presence in the river corridor and the problems in communication that led to many of the conflicts about appropriate river recreation use. Their analysis mentions the role of visitor education and information as well as provision of stopping places along the river in helping manage the problems of trespass on private lands, with resultant recreation-related conflict.

Limiting Is Legal, BUT ...

Research by Simpson and McAvoy (1987) explored the legislative and legal foundations for establishing carrying capacity on the Upper Delaware. Legislative intent calls for general preservation to maintain conditions and values that existed at the time of river design-

nation. Management guidance is offered by requiring that carrying capacity be reviewed on a 5-year basis to determine if overuse is occurring. If so, appropriate steps to reverse the environmental damage must be taken. In reality, the legislation does not give explicit direction on limiting recreational use nor does it rule out establishing carrying capacities and developing strategies to limit use. No specific methods of implementation are identified or recommended.

Research to date points away from an aggressive effort to set limits on recreational boating on the Upper Delaware – at least based on current recreational use levels, observed impacts, and guidance from a variety of interest groups. The majority of the river user groups are satisfied with current conditions, and limiting use would seem, by itself, a poor solution to existing problems.

Where Do We Go From Here?

Most of the apparent problems seem not to be problems of numbers of people or boats. They are problems related to human behavior. These problems call for a variety of actions, including improved communication among people and groups, more effective law enforcement, a greater number or more appropriately located facilities or visitor services, and improved education for visitors in trip planning, appropriate river etiquette, and outdoor skills.

Partnerships to develop and implement such actions between the NPS and the various groups and persons

interested in river issues could enhance the long-term health and vitality of the Upper Delaware as a quality scenic and recreational resource.

Lime is a research associate at U/Minn's Dept. of Forest Resources, St. Paul and Unit Leader of the NPS/CPSU at U/Minn. Karish is Chief Scientists, NPS Mid-Atlantic Region, Philadelphia, PA.

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